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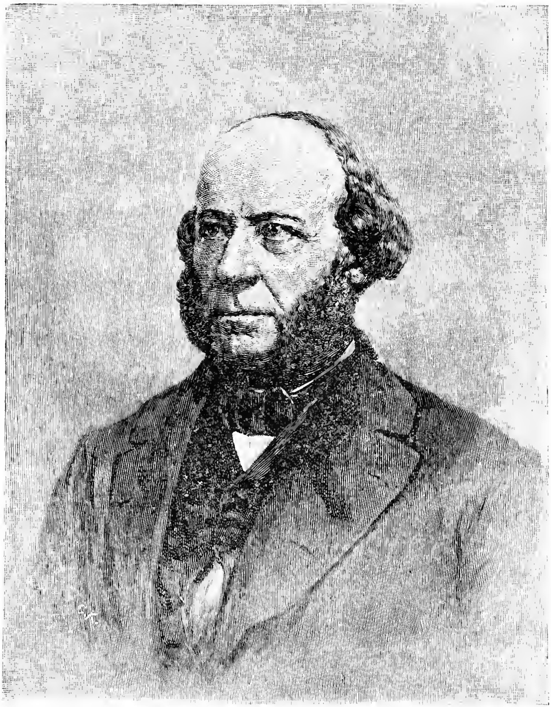

with profound respect
Your obedient Servant
J. Ericsson

[At the time he built the Monitor, 1861.]

THE LIFE

OF

JOHN ERICSSON

BY

WILLIAM CONANT CHURCH

ILLUSTRATED

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CHAPTER XIX.

RESULTS FOLLOWING THE SUCCESS OF THE MONITOR.

Confidence of the Government in Ericsson and His Plans.—Other Monitors Ordered.—Nautical Doubts.—Yielding to Professional "Clamor."—Opinion of Admiral Rodgers.—Double and Single Turrets.—Bureau Opposition.—Imperative Demand for Armor-clads.—Commodore Smith still Criticises.—Misconceptions Concerning Monitors.—Captain Fox converted.—Ericsson's Report to the Department of State.—The Dictator and the Puritan.

EVEN before the success of the *Monitor* was finally assured, and public approval had concentrated upon Ericsson, he was able to inspire the authorities at Washington with sufficient confidence in his plans, and in his ability to carry them into execution, to induce them to wait upon him before giving a hearing to others, and while the *Monitor* was still on the stocks it was decided that armored must supersede wooden vessels.

"I wish we had your vessel now," Commodore Smith wrote, November 11, 1861. "The Government must create a fleet of plated gun-boats. They will cost much less and be more effective than the army. I think the Department contemplates augmenting this description of force. I am good at making objections and finding faults that may not exist, nevertheless, my zeal and great anxiety for the success of those *first attempts* does not abate."

January 6, 1862, Mr. Winslow reported that the Navy Department would not authorize more than one or two boats on the Bureau plan until one of the Ericsson batteries was put to proof. Mr. Winslow had it "from the *very* highest source" that if that proof was satisfactory, contracts would be given

for as many of the twenty additional armored vessels projected as he and his associates could build.

"You cannot imagine," wrote Mr. Winslow, January 10, 1862, "the intense and almost agonizing anxiety of all the heads, from the President down, to have one boat *to use*, and when I told them that she would be afloat and ready for use within *one hundred working days* of date of contract, they raised their hands in amazement and gratitude. I assure you the energy and despatch exhibited in the construction of this battery is unequalled (or unheard of) by any contracts made by the Government in any of its departments, and will give us a position and influence with the Government in any future contracts that will be almost controlling, and if the battery comes up to what we have promised, I tell you in all sincerity that other plans and other contractors *will be nowhere*. Our 'prestige' will be hard for others to overcome."

The chiefs of the Bureaux of Construction and Steam Engineering were not disposed to permit all the honors to accrue to a man outside of the charmed circle of official life, and they made strenuous efforts to secure the adoption of projects of their own, and steadily antagonized those of Ericsson. They could do no more than to embarrass the Assistant Secretary, and the Chief of the Bureau of Yards and Docks, in carrying out their plans concerning Ericsson, by stirring up the doubts which not unnaturally arose as to his ability to accomplish all he had undertaken.

The bill appropriating ten millions of dollars for armored vessels became a law. By it the question of determining the choice of plans was left to the decision of the Secretary of the Navy. This meant practically Assistant-Secretary Fox, upon whose judgment and patriotism Secretary Welles justly placed the greatest reliance. That noble old sea-dog, Commodore Smith, in spite of his sailor disposition to grumble and criticise, had firm faith in Ericsson personally, and in his vessel more than in any other iron-clad. He does not appear to have had unlimited faith in armored vessels at the best, but he seemed convinced, at least, that—to quote a phrase from Abraham Lincoln—"for those who liked that sort of thing," Ericsson's *Monitor* was "just the sort of thing they would like."

"Commodore Smith is much pleased thus far and favors

you," wrote one of Ericsson's Washington correspondents, February 8, 1862. Two months before this, on December 12th, the Commodore had himself said: "I am overwhelmed with a rush of proposals for iron-clad vessels and rams of different sorts." To none of these was any heed given, for Mr. Bushnell wrote again, February 26th: "I found on inquiry that no plans, drawings, or anything of the kind have been made yet for the proposed twenty iron-clad vessels—in fact, I have it from the highest authority that everything depends upon the test of your battery, and that until after her trial nothing will be done."

The demand for armor-clads had now become imperative, and upon Ericsson's broad shoulders was to rest the main burden of carrying the Government through the crisis precipitated by the advent of the *Merrimac.* By the 16th of March, 1862, or within one week from the encounter in Hampton Roads, he had received and accepted a proposition to construct six gun-boats on the plan of the *Monitor.* Four were to be completed on or before the 31st of July following, that is, within a little over four months, the two others within another month, or on or before the 31st of August. Commodore Smith still adhered to his opinion that he knew better than her builder what a monitor should be and insisted on various modifications in the original plan. It was evident to his mind, among other things, that the *Monitor's* deck was "too near water to weather the coast or even fight successfully in the Chesapeake Bay."

To persuade a sailor that he could with safety go to sea in a vessel with a deck so low that the water, even in ordinary weather, made a clear breach over it, was like an attempt to induce a Catholic to accept the Westminster Catechism, or a Presbyterian to declare his belief in Papal infallibility. When one of the monitors was in subsequent years sent abroad, Mr. Fox tells us that "the English pilot who accompanied her from the Thames was somewhat suspicious of the strange craft, and had his doubts of her ability to stand a heavy sea. He afterward said that the first gale that he encountered, when he saw a green sea, eighteen feet deep of solid water, roll over her bow, he gave himself up for lost, believing that the vessel was going down head foremost. But, the tops of the turret keeping clear of the terrific waves, he gathered courage to look around, and, seeing

an American sailor quietly sewing a patch upon his trousers, apparently unconscious of the coming on board of the water, which all his experience had taught him was fatal to a ship, he regained his equanimity."

This misconception has by no means disappeared even now, and it was universal with sailors at the time Ericsson's first vessel was put into commission. The very idea of such a misbegotten craft violently shocked nautical preconceptions, and no doubt if the rest of the Chief of the Naval Bureau of Construction was ever disturbed, his nightmare assumed the form of a voyage in a monitor with Mephistopheles, in the guise of Ericsson, figuring as skipper.

Fortunately, Assistant-Secretary Fox was by this time a complete convert to the monitor system. In a letter dated March 18, 1862, he said:

> When I spoke to you last summer of a vessel of extraordinary speed and one twenty-inch gun, invulnerable so far as the tower was concerned, as a fit match for the *Warrior*, I did not think that you would take the *Monitor* as a type. But my visit to Old Point, and the conversations I have held with those on board during the passage from New York, as well as the reflections which have impressed themselves upon my mind from witnessing her contest with the *Merrimac*, lead me to concur fully in the plans which you showed me in New York Saturday. I shall venture to offer some suggestions of detail, and you will receive them in the kind spirit which prompts them. Ever since my connection with the Department, I have used every proper opportunity to awaken an interest in iron-clad vessels, and very many associated with me, and most especially the Secretary, have felt an awakening, but the public slept. Most fortunately, we have met with a disaster—this is the Almighty's teaching always—success never gives a lesson. . . .
>
> We ought to have a dozen monitors at least instead of six. How many can be made in the country, including your fast boat?

Ericsson's new monitors of the "*Passaic* class," as they were called, were soon fairly under way. With his usual energy he had commenced upon his working drawings as soon as the vessels were verbally agreed upon. His mind was a storehouse of principles and precedents from which he drew the material for new adjustments and applications of the mechanical powers. There was in his case, therefore, no need to delay for the

laborious reference to authorities. When he had an important piece of work on hand he would be found occupied for several days with his own thoughts, and seemingly idling away his time. Then he would call for drawing-paper, and plans would fly from under his hands with such rapidity that the swiftest draughtsman could not follow him, and with such completeness of detail that he did not find it necessary to examine his work after it had left the shop. The drawing representing the part of the machine requiring the most work appeared first and the others followed in their order. One went to this shop, or this department, and another to that, and no one knew what the completed structure was like until the several parts were assembled, each fitting in the others like hand to glove. Well might Ericsson say that he was able to despatch work as other men could not, because his methods of work were unlike those of other men.

A month after Commodore Smith had written officially, stating that a verbal agreement had been made with Ericsson's representatives for six more vessels, we find him saying, under date of April 14, 1862: "So much importance has been attached to verbal agreements and conversations that I feel it incumbent upon me to say that no contract is binding but that which shall be reduced to writing. In all this the Department does not doubt your fidelity and ability, and has every confidence that you will sustain the high professional reputation you now enjoy."

This was well enough, but Ericsson might have retorted that if he had waited for the completion of a written contract, before beginning work upon the *Monitor*, she would not have been at Hampton Roads on the morning of March 9th to stay the devastating progress of the *Merrimac*. The written contract was finally filed in the archives of the Navy Department, and so prompt had been Ericsson's action that he was able, on April 23, 1862, to write to the Secretary of State, Mr. Seward, saying:

NEW YORK, April 23, 1862.

SIR: The state of the naval defence of the country being so intimately connected with its international relations, I deem it my duty to report to you that, under orders from the Secretary of the Navy, keels for six vessels of the *Monitor* class of increased size and speed have already

been laid, I have contracted to deliver these vessels in four months from the present time, and feel confident of being able to fulfil the agreement. The amount of mechanical force now concentrated on the work is quite unprecedented.

The speech of the Duke of Somerset in the House of Lords, on the 4th inst., and the news from England to-day in relation to the expedients now adopted by the Admiralty to avert the dangers suggested by the recent developments in naval warfare, tend to prove that this country now occupies the vantage ground. The six vessels above alluded to will be absolutely impregnable against even the last "14-ton gun" of Armstrong, in consequence of their sides being only eighteen inches above water, a circumstance which converts their decks into bulwarks supporting the armor plate with resistless force. Our turrets, too, are absolutely impregnable, as we now make the same 11¾ inches thick—all iron. Our guns of 15-inch calibre will throw 450-pound shot. To this enormous projectile, the *Warrior*, *Black Prince*, and the razeed line-of-battle ships will present only a five-inch iron plating. This thin armor may be said to offer no resistance to our 450-pound shot. Under its terrific impact, the sides will be actually crushed in. England is now committing the serious blunder of attending to the protection of her guns alone by the so-called cupolas. She overlooks the safety of the vessel intended to carry her guns. The British Admiralty, it would appear, can only see in the *Monitor* a revolving turret (erroneously supposed to be of English origin), forgetting that without the peculiarly constructed hull of the *Monitor*, her cupola ships will stand no chance in a conflict with this country.

I am, Sir, respectfully,

Your obedient servant,

J. ERICSSON.

HON. WM. H. SEWARD,
Secretary of State, Washington.

The vessels referred to were the *Passaic*, *Montauk*, *Catskill*, *Patapsco*, *Lehigh*, and *Sangamon*, so named by the Department, which happily saved the navy from the misfortune of having them called, as was first proposed, the *Impenetrable*, *Penetrator*, *Paradox*, *Gauntlet*, *Palladium*, *Agitator*.

June 18, 1862, Mr. Fox wrote a private letter to Ericsson, saying: "The Secretary has to-day decided to let you build two vessels of the big class—one of one turret and one of two turrets. I am sorry it is not four, but if no new plans are presented within a few months, it may be considered by him desirable to build two more. The official letter will go to you at once for two."

To this most welcome communication this reply was sent:

NEW YORK, June 19, 1862.

DEAR SIR: The receipt of your brief note of yesterday is an event in my life—I might say *the* event—as it conveys the intelligence that you are going to open to me a full, fair field where I can concentrate in one focus the result of all the experience gained and knowledge acquired during my long and arduous mechanical career. I will not detain you by complimentary expressions, but simply say *all* my energies will be exerted to merit, as far as possible, the extraordinary confidence you place in me relative to your war ships.

Yours truly,

J. ERICSSON.

HONORABLE G. V. FOX,
Assistant Secretary of the Navy, Washington.

The two vessels "of the big class" were the *Dictator* and the *Puritan*, referred to in the previous letter as the "fast boats." In reference to their names Ericsson wrote: "I am much gratified that the name *Dictator* for the first turret ship has been approved of. I have given the shop name *Protector* to the long vessel, but I lack the courage of asking for approbation, having already, in such a handsome manner, had my desire twice gratified. You will much oblige me by naming the ship at once. There is greater practical convenience in *starting* with the right name than you probably are aware of." The name *Puritan* chosen for the second vessel was an improvement on that here suggested.

Specifications for these two vessels had been forwarded on May 19, 1862, but they were delayed in the Bureaux at the Navy Department; so that it was not until June 30th that Ericsson was able to acknowledge the receipt of the amended specifications for the first of the two vessels, the single-turreted monitor *Dictator*. Without delay he wrote: "The specifications will be amended and returned at once. Some of my associates advise waiting to have the contract signed."

This advice was certainly sage, in view of the warning received from Commodore Smith; "but," continues Ericsson, "I have put the ship-house in hand, and will order the keel-plate to-morrow. Numerous other preparations are, and have been, under full headway for several days." The contract was not

finally completed until July 28, 1862, "for the construction of two iron-clad, shot-proof sea steamers of iron and wood combined, amounting in the aggregate to $2,300,000." The notification that the tender for these had been accepted by the Navy Department was not received until August 8th. Meanwhile, that the country might not suffer from the delay, Ericsson had proceeded with the work at his own risk.*

The confidence Ericsson had inspired at the Department, among those who were not influenced by professional prejudice, is shown by a letter of June 9, 1862, from Mr. Stimers, who said: "You will not be interfered with in your arrangements. The Secretary and Mr. Fox have the greatest confidence in your skill and uprightness, and you see by Mr. Fox's letter of this date, that your plans are not criticised. I consider that they take as much responsibility as could be expected from

* The formidable character of the work Ericsson had undertaken in making himself responsible for these eight armor-clads, is shown by a comparison of their dimensions with those of the original *Monitor*:

	Monitor.	Passaic, class (6).	Dictator and Puritan.
Contract price each	$275,000	$400,000	$1,150,000
Extreme length, feet	172	200	312 and 340
Extreme breadth, feet	$41\frac{1}{2}$	46	50
Depth of hold, feet	$11\frac{1}{3}$	......	$21\frac{2}{3}$
Draught of water, feet	$10\frac{1}{2}$	$10\frac{1}{2}$	20
Inside diameter of turret, feet	20	21	24
Thickness of armor, inches	8	$10\frac{1}{2}$	15
Diameter of propellors (2), feet	9	12	$21\frac{1}{2}$
Diameter of steam cylinders, inches	36	40	100
Length of stroke, inches	24	22	48
Side armor, inches	$4\frac{1}{2}$	5	6
Weight of guns, pounds	44,000	84,000	84,000 220,000
Coal, in tons (2,240 lbs.)	100	150	300 and 1,000
Total displacement, pounds	2,210,000	2,990,000	9,942,000 11,002,000
Midship section, square feet	321	392	777

A portion of the length of these vessels was represented by the overhang, that is, the part of the deck extended over the immersed hull—in the case of the *Dictator* 13 feet forward and 31 feet aft, and over the sides 8 feet 4 inches, leaving the dimensions of the under vessel 270 feet length and 41 feet 8 inches beam.

them when they decide in favor of your plans *in direct opposition* to the views of the Bureau officers." It was, certainly, very exceptional for the civilian head of a department to act in defiance of professional advice. This result was due not alone to the success of the *Monitor*, it was the fruit of that confidence in his integrity, his zeal, and fidelity, as well as in his ability, which John Ericsson always inspired in the men who knew him. He was honest, and upright, and faithful, because it was part of his inborn nature to be so, and no temptation could make him otherwise.

Though honest men may not always have the discernment to detect the rogues, they have an instinctive perception and appreciation of the characteristics of men of their own sort. This was the secret of the friendship that sprang up between Gustavus V. Fox and Ericsson, and continued until the death of Mr. Fox. Innumerable letters exchanged between them show how complete was their confidence in each other.

It is to the credit of Mr. Welles and Mr. Fox that they were able to step aside from the path of routine to make available for the public service the genius of a man like Ericsson. They estimated at its proper worth the experience and ability enabling him to conceive in all their details the plans of a great fighting machine like the *Dictator*, and prepare them at his drawing-table with such skill and accuracy that, when the three thousand different parts that made up the whole were brought together by the mechanics, not a single alteration in any particular was required.

In contracting for the *Dictator*, the Department conferred upon Ericsson the extraordinary privilege of constructing the ship and her machinery after his own plans. When he had undertaken the work under the contract, he was repeatedly urged to introduce any improvement suggesting itself to his mind, so fertile in mechanical expedients. The changes made were partly the result of the experiences at sea and in battle, which the smaller monitors were undergoing while the *Dictator* was building, and were so numerous that the "supplementary specifications" for the vessel were nearly as long as the list of specifications under the original contract. "A more thorough development of the new system, together with the ex-

perience gained in actual warfare, since the original contract was entered into, has," it was stated, "called for the following additional work."

It was, of course, impossible to calculate in advance the cost of such improvements, or to make them the subject of exact specifications and contracts; so Ericsson was obliged to proceed under a general promise from the proper authorities that he should be compensated for his extra work. Among other changes, a water-tight inner skin was added and a water-tight deck of iron forward—to prevent leaks from the concussion of ramming—and a wooden deck between the deck beams and underneath the main deck, to keep out any water working through from above. Access to the turret chamber was made more available, the sight-holes improved, and a better method of inserting the bolts adopted, as injury had resulted to occupants of the turrets by boltheads flying off during an engagement.

"In obedience to the universal clamor of naval officers," Ericsson very reluctantly discarded the forward overhang, designed for the protection of the anchor. This hung in a well underneath it and could be dropped and lifted under fire without injury. From this anchor-well, as Lieutenant Greene, executive officer of the original *Monitor*, complained, came a sound resembling the death groans of twenty men, the most dismal, awful sound ever heard. It was certainly not music to the ears of men just going into battle, but the explanation of it was very simple. The "hawse-pipe," or aperture for paying out the chain cable, was underneath the overhang, and so near the water-line that every time the vessel pitched forward the water rushed into the pipe, driving the air before it, and creating the ghostly sound described by Lieutenant Greene. Water also got into the vessel through the hawse-pipe, when, as was sometimes the case, there was a failure to stop up the opening around the chain cable.

This forward overhang Ericsson parted with very unwillingly, for it had proved a perfect protection to the anchor under severe and protracted fire from the enemy's batteries; whereas the anchor of the *Merrimac* was shot away in her first day's engagement with the *Congress* and the *Cumberland*.

Discarding the overhang, compelled the adoption of some efficient mechanism for handling the anchor. This was devised after much study, but the problem was a very difficult one.

When the *Dictator* went into service, her commander, Admiral John Rodgers, one of the naval officers who always showed an intelligent interest in the new style of vessel, wrote to complain of the absence of the forward overhang. In reply Ericsson said, with some bitterness, that criticism had compelled him to yield this feature of the original *Monitor*, as it had been vehemently condemned by a majority of the monitor commanders. In a letter sent to the Secretary of the Navy, in replying to the criticisms of the commander of one of his vessels, he also said: "I trust that neither he nor the other officers of the turret vessels, all of whom are admitted to be as skilful in their profession as they are brave, will take offence at my remarks. I have only the single object in view —the triumph of the service which their skill and valor have raised so high in public estimation. I beg earnestly, however, to call their attention to the fact that they have entered on a new era, and that they are handling not ships, but floating fighting machines, and that, however eminent their seamanship, they cannot afford to disregard the advice of the engineer."

The importance of protecting the steering gear was shown during the naval engagements of our civil war, and has been shown since in the few instances where ships have been tested in actual battle. In the engagement of July 20, 1866, between the Italians and Austrians at Lissa, nearly every one of the forty and more vessels engaged made one or more attempts to sink an adversary by ramming. The only vessel sunk was the *Re d'Italia*, whose steering gear had previously been injured by gun fire. The only effective ramming in the Paraguayan war was against a vessel already disabled. The Chilian *Esmeralda*, in the battle of Iquiqui, May 21, 1879, was sunk by the Peruvian *Huascar*, only because she was unable to move. From a study of such examples W. Laird Clowes concludes that " a ship, so long as she can keep way on her, and so long as she can steer, need not fear an enemy's ram, provided, of course, that she be properly handled. The immediate cause of the loss of the *Independencia* and *Esmeralda*, the *Re d'Italia*,

and many other vessels, was the sudden disabling and tardy repairing of the steering arrangements.*

Ericsson opposed the Department's idea of two propellers and two turrets, but he was compelled to introduce them into one of his two large vessels, the *Puritan.* The changes from his plans were the fruit of English example. He wrote Mr. Fox, August 5, 1863, saying:

> With us it is different. I built upward of forty double-propeller vessels for coast and lake navigation in this country nearly twenty years ago. Not one of the parties for whom those vessels were built would now employ more than one propeller! The advantage of being able to turn the vessel around on the centre has charmed the naval men of England. Now, this may be done as effectually with one screw in vessels having a stern overhang. While you consider this proposition, you will render the country an inestimable service by making up your mind to render the *Puritan* impregnable by putting three-inch plating on her deck, and dispense with the after-turret. Mark my word, the day is not far distant when two turrets on a vessel will be admitted to have the same advantages as two heads on the human body, or two suns in the heavens. There are advantages in either case, but the disadvantages are innumerable. I propose to resume this subject on another occasion, after it shall have been proved practically that any amount of force may be concentrated in one gun. It is ships built to meet the enemy on the ocean, or beyond the ocean, that I contend should have single turrets. The proposition is incontrovertible that when all the resources of mechanic art have been employed on either side, the nation that puts a fleet of double-turret ships to sea will do so to be utterly annihilated by the nation that employs the single-turret ship with its greater speed, greater impregnability, and heavier ordnance. Some time may possibly elapse before the experience and advice of brave admirals in favor of broadsides will be disregarded, before the fact will be admitted that the single shot in which the entire weight and impact of a whole broadside is concentrated, can destroy that which a hundred broadsides cannot harm. But the time *will* come—truth is mighty and will prevail.

This reasoning prevailed at that time, and two years later, on November 14, 1865, Ericsson was able to write to John Bourne, in England: "The after-turret of the *Puritan*, mate of the *Dictator*, but 21½ feet longer, will be dispensed with, and her *single* turret will have two 20-inch guns, each weighing 96,000 pounds, with spherical solid shot of 1,000 pounds weight.

* Naval Warfare, 1860–1889, and Some of its Lessons, in Journal of the Royal United Service Institution, 1890, No. 193.

This change is quite a triumph for the writer, who insists upon it that a perfect fighting ship should only have one turret sweeping the entire horizon with the weight of the two or three turrets, and their guns concentrated in one turret and one pair of guns. This concentration gives a thickness to the turret insuring absolute impregnability and guns of such calibre as to crush an adversary at a single blow." This was a correct statement of the purpose of the Navy Department at that time, but it was not carried out, as the *Puritan* was never completed. The armor-clad vessel of that name now in the United States Navy is the same only in name.

Though the intention in the beginning was to allow Ericsson entire freedom in carrying out his plans with reference to the *Dictator*, it would appear that the pressure upon the civilian chiefs of the Navy Department who had such confidence in him was too powerful to be resisted. Explaining, in a confidential letter, dated January 7, 1868, why he deviated from his original design by tapering off the side armor plating, he said:

The whole blame rests with the Secretary of the Navy for allowing himself to be humbugged by the Steam Bureau Chief, compelling me to put some 600,000 pounds additional and useless weight into the vessel after the plans had been approved and the price fixed. But I cannot, on personal and political grounds, at this moment expose the gross blunder of the Department. The fact is, Isherwood, in conjunction with others, was determined that I should not build the *Dictator* and *Puritan*, and therefore, in a very adroit manner, imposed conditions which he thought could not be filled without the vessels sinking. On the other hand, I was determined to build the vessels, and accordingly accepted the apparently impossible conditions; of course my destruction was predicted by the opposition. It would be too long a story to tell how I saved the 600,000 pounds, and what labor it cost. Suffice it to say that the tapering off the side armor plating was one of the expedients resorted to.

Having adjusted his plans to the new conditions, Ericsson was able to report on July 2, 1864, that the last of the two heavy iron-clads, the *Puritan* and the *Dictator*, had been successfully launched that morning, before 9 o'clock. "In proof," he says, "of the accuracy with which my plans have been carried out, and the great exactness on the part of all who have

furnished iron for the ship, I have to report that the draught of the ship at the midship section, through centre of forward turret, proved to be 11 feet 10¾ inches, while the launching plan called for eleven feet eleven inches—difference one-fourth inch less draught than calculated. As the *Dictator* proved equally accurate, it cannot be said that our success is the result of chance. The extreme point of stern overhang is 2¾ inches higher out of water than indicated on my plan—an advantage not owing, however, to inaccuracy, but in accordance with my instructions to the builder, while setting out the work, to 'keep the after-end of the overhang well up.'

"I have deemed it proper to advert to these facts in refutation of the prevalent notion that the draught of iron-clads cannot be accurately predicted."

Just previous to launching the *Dictator*, October 22, 1863, Ericsson addressed this gallant invitation to Mrs. Fox through her husband:

> Can you induce Mrs. Fox to perform the ceremony of naming the *Dictator* at the launch? With such a strong incentive as her consent to grace the occasion with her presence, we can readily overcome any number of impossibilities that may present themselves in deepening the river and strengthening the dock between this and November 2d. Before deciding unfavorably, I trust Mrs. Fox will give due weight to the fact that not only this continent but all Europe take a deep interest in the proceeding. Victoria, Napoleon, Alexander, and even the Grand Turk watch with anxiety the advent of the great ship, the iron deck of which may be said to possess power to crush the foundation on which thrones are supported.

Some difficulty was experienced in getting the *Dictator* into the water, owing to a disregard of the precautions considered necessary by Ericsson. To Admiral Paulding he said:

> The launching-ways of the ship were not laid under my direction. The builder of the hull delivers the vessel to me at the wharf at his own risk. The inclination of the ways did not meet my approbation, but as the ship-builder employed by Mr. Delamater to launch the vessel, insisted that it was sufficient, I could only express my doubts. After the completion of the ways I had the same accurately levelled and ascertained by calculation that the ship could not move unless other force than gravitation were applied. Accordingly, I provided six steam tugs, much to the amusement of those whose "practical" knowledge entitled

them to assert positively that the launch would be successful without applying steam-power. The enormous force employed yesterday without success has now, I am most happy to inform you, convinced those concerned that greater inclination must be given to the ways. Accordingly, the ship is now being put on the blocks, the ways will be rebuilt and the bulkhead cut down three feet in order to obtain the required inclination.

It was not, however, until December, 1864, that the *Dictator* went into commission, under command of Commodore John Rodgers, and was made ready for sea, sailing from New York on the afternoon of December 15th, and arriving at Fort Monroe on the 17th. Her completion had been eagerly awaited, and as early as March 23, 1863, previous, Mr. Fox wrote, saying: "Whether the Government, now using every honorable exertion, will succeed in stopping the sailing of the Confederate iron-clads from England I know not, but I beg of you to use every exertion to get the *Dictator* and *Puritan* ready for sea. They will be our main dependence."

One most important problem which it fell to the lot of the Navy Department to solve at the beginning of the war was to neutralize the aggressive power of the iron-clads belonging to foreign powers, whose attitude of armed neutrality might at any moment change to one of hostility. By the adoption of one of two methods only could this have been accomplished. First, by copying the English and French craft; types of iron-clads so erroneous in principle that even their great advocate, Scott Russell, admitted that they must have from 12,000 to 20,000 tons displacement to attain impregnability, with the other essential qualities. To this course these strong objections presented themselves; the cost of the *Warrior*, *Bellerophon*, etc., was about two million dollars in gold for each vessel, and such vessels would have cost the United States at that time from five to six millions each, or much more than the price of the whole fleet of monitors of the *Passaic* class, and it would have taken at least two or three years to build them. If vessels of this description had been decided upon, it would have been almost impossible, in the first place, to have had them built, and they would have been valueless when done, as their draught of water would have precluded their use for blockading

or operating against the Confederate ports in any way. In fact, if the Britons had presented us with their whole fleet of colossal iron-clads they would have been useless for service along our coast. They could scarcely approach within sight of it from Cape Henry down, and if kept in commission would have taken a whole army of sailors to man them, to say nothing of their other expenses. The only thing which could have been done with them, provided we had possessed a navy yard of sufficient depth of water, would have been to have placed them "in ordinary" against the contingency of a foreign war.

The second method open to the Department was to adopt the system of Ericsson, as the only one upon which iron-clads of small size, light draught of water, impregnability, and the power to use the heaviest ordinance (as well as quickness of construction) could be built. These vessels could be used against the Confederates, as well as to protect our large harbors from foreign iron-clads, should that emergency arise.

The principle on which the monitors were built is one good for all time; the character of the particular vessels for which Ericsson was responsible is to be judged by the standards of that day. From this point of view the *Dictator* must be regarded a most formidable vessel; superior as a fighting machine to anything afloat at the time she was completed. Though Ericsson was over-sanguine as to the speed she could attain, even in that respect she compared favorably with the best of the foreign armor-clads. She was intended to have a speed of sixteen knots, but he was compelled to adopt a form of boiler he did not approve and the upper tier of furnaces could not be used and she fell somewhat short of twelve knots. The British *Warrior* had only attained 14.4 knots and the *Black Prince* 13.6 on the measured mile in smooth water, with boilers new and free from scale, bottom of vessel clean, using picked coal and employing trained stokers. These conditions do not prevail in ordinary service, and least of all did they prevail during our civil war, when everything had to be improvised, naval engineers and stokers included. Under like conditions the speed of the *Dictator* would not have been far from that of the best of her transatlantic rivals. It certainly equalled that of British vessels nearer her own size, such as the

Resistance, *Defence*, and *Royal Oak*, taking size to mean length and breadth and not displacement, her draught of water being but twenty feet, while theirs was nearly twenty-five feet.

In steering and handling qualities, the *Dictator* was vastly superior to her rivals. Her pilot reported that it took but two men at the wheel, and that she was easier to handle than other vessels of half her tonnage, making turning in a circle of only 700 feet diameter. The English iron-clad *Achilles*, with the same engine power, required fourteen men at the wheel with half boiler power and twenty-one men with full boiler power, and required a circle of 3,000 feet diameter in which to turn, and ten minutes for the operation. These are important differences in fighting vessels.

"All our officers are delighted with the *Dictator*," wrote one of them to Ericsson on her first trip, "as she is without exception the most comfortable and finest ship in the United States Navy." "The vessel steers beautifully," wrote Commodore Rodgers from off Ellis Island, on his way out of New York harbor on the initial trip, November 15, 1863. "The steerage of all the monitors is peculiar, and it requires some little practice to become expert, but afterward it is extremely satisfactory. I think I can congratulate you already upon the success of the *Dictator*. As a whole she is a grand triumph, for she gives clear indications that when tested she will be thoroughly satisfactory."

The opportunity for the supreme test never came, for the war was so far advanced before the *Dictator* entered the service that she was never subjected to the gauge of battle. The *Puritan* was incomplete when the war closed, and there being no immediate demand for her services, work upon her was suspended for ten years, and until the threat of war with Spain, under the administration of General Grant, led our Navy Department to make active preparations for an emergency.

With reference to the *Dictator*, Ericsson wrote to President Lincoln, December 9, 1864:

This ship is now attracting great attention on the part of European governments. Naval officers of all the leading powers have closely watched her construction. With regard to impregnability and power of armament, all have admitted that Europe has nothing that can cope

with the *Dictator*; but her perfect "habitability" has not been admitted until now that the arrangements for promoting ventilation, light, and comfort have been completed. It must be gratifying to the Secretary of the Navy that the condition which he has rigidly enforced in the construction of the iron-clads, to protect the crew as well as the armament, has recently been accepted by the European naval powers as an indispensable condition. You will contemplate with pride, sir, that while your entire iron-clad fleet has, through the sagacity of the Navy Department, been built on a correct principle, England is now engaged in reconstructing those costly but only *partially* mailed ships which but yesterday she deemed perfect and invincible.

Possessing peculiar facilities for becoming acquainted with the views of the naval authorities of Europe, I deem it my duty to say that the extraordinary progress and success of your navy during the war is fully appreciated. The attention of your maritime rivals appears equally directed to the magnitude of the material resources developed and to the unparalleled energy of your naval administration.

To the Secretary of State, Mr. Seward, Ericsson wrote, February 5, 1864, that the *Dictator* had been examined by officers sent for that purpose by the Emperor of the French, who were about to return to France with information concerning our iron-clad fleet not agreeable to the gentleman who was seeking to strengthen the foundations of his throne by an alliance with the House of Austria against the peace of Mexico and in defiance of the Monroe doctrine. "These officers," wrote Ericsson, "admit that they came here thoroughly opposed, but return converted, to the monitor system. They do not attempt to disprove the proposition that the broadside vessel with her numerous small guns cannot resist the crushing effect of the heavy turret guns."

In February, 1874, ten years after the *Dictator* was completed, Ericsson wrote to a friend in Sweden.

The *Dictator* is now at Key West in fine condition. As usual, a vessel has been ordered to accompany the monitor during the voyage; but in a gale off Savannah this vessel made port while the *Dictator*, with her fine sea-going qualities and plenty of coal in the bunkers, proceeded without her companion. This circumstance gave rise to rumors that the *Dictator* had been lost after having, as the stupid papers relate, "parted the hawser by which she was being towed." The *Dictator towed!* why, this ship exerts a direct pull of fully 80,000 pounds, and is capable of towing any ship of war in existence at the rate of seven miles.

CHAPTER XX.

DISASTROUS INTERFERENCE WITH ERICSSON'S PLANS.

Ericsson's Disinterested Patriotism.—Pecuniary Embarrassments Resulting from it.—Call for Light-draught Monitors.—The Prompt Response.—Unfortunate Result of Interference with Ericsson's Plans.—Twenty Millions Wasted.—His Efforts to Prevent Disaster.—His Magnanimity.—His Military Foresight.—Recommends a Repeating Rifle.—A Plan for Flying Artillery.

IN addition to the six monitors of the *Passaic* class and the *Dictator* and *Puritan*, built by Ericsson and his associates, the inventor of the *Monitor* was called upon to furnish plans for four other monitor vessels building at the same time. These were the *Nahant*, *Nantucket*, *Weehawken*, and *Comanche*, all built on the model of the *Passaic*. Ericsson's associates, on being informed that he had agreed to furnish duplicate plans to the contractors for these vessels, reminded him that this would bring him into competition with others who had the great advantage of getting for little or nothing what had cost them much money. His reply was that he felt in duty bound to assist the Government to the extent of his power to meet the emergency of war.

They yielded to the argument of patriotism but the result feared soon followed. Competition led to an active demand for labor and material, and those who worked from Ericsson's matured plans, made castings from his patterns, and duplicated his wrought-iron work, had every advantage over him. Everything entering into the construction and outfit of the vessels for which he had contracted advanced rapidly in price, while the amount he was to receive was fixed and unchangeable. The Government, in accordance with its usual custom, reserved one quarter of his contract price to secure the fulfilment of its stipulations, and at the same time insisted that the vessels

should be put into service without waiting for this final payment. The machinery, just from the workshop, was subject to the severest of all tests, and entrusted to the care, to a large extent, of young and inexperienced engineers, who, following the rule of poor workmen quarrelling with their tools, were ready to throw upon the contractors the responsibility for their own blunders.

Before the work on the six monitors was completed, Ericsson found himself embarrassed for the want of the money reserved from his contract price on the vessels, amounting altogether to $600,000. On February 5, 1863, he requested the payment of the reservation upon the four vessels already delivered, calling attention at the same time to the fact that it was wholly unprecedented to expose the work of contractors to the chances of war before paying for it; adding, "the vessels for which we now solicit the full payment of $400,000 each cannot this day be purchased for less than half a million dollars."

As the war progressed, assumed greater proportions, and the Union armies penetrated into the interior of the Southern territory, the navy occupied and patrolled the great rivers and the numerous estuaries. The class of vessels upon which they depended for protecting the army communications were wooden boats of light draught, purchased from the merchant service. Their machinery, boilers, and magazines were above the water-line, and they were too frail to carry anything but light iron bulwarks to protect their crews against sharpshooters hiding behind trees on the river bank. The enemy found many high points upon their inland waters where they could plant batteries of artillery, looking down upon the gun-boats and out of reach of their heavy guns. Gallant attempts to attack such batteries, to pass them, and to keep open the army lines of communication, resulted in fatal disasters and serious loss of prestige. From every squadron and flotilla the Department was called upon for a light-draught iron-clad vessel, able to resist the ordnance used by the Confederates. The urgency of the demand, and the painful accidents and disasters constantly occurring, could not be treated with indifference. An invulnerable vessel of light draught had not only never been attempted, but an extended inquiry gave no encouragement that one could be designed.

In this emergency the Navy Department applied again to Ericsson. On August 4, 1862, Mr. Fox wrote to him saying: "I wish somebody of brains could give us a six foot draught boat of great velocity and high pressure for the Western waters, impregnable like your boats. We have plenty of three-inch plating, but the rebels seem to beat us in their *Arkansas*. They have also got an iron-clad nearly ready at Richmond and Savannah and two nearly ready at Charleston, and we are nowhere. The Confederates are setting an example of perseverance and faith in the iron-clads."

Casemated vessels run aground on the inland waters were helpless, whereas a turreted vessel discharged her guns toward every point of the compass, whether aground or afloat. This was exemplified when the *Osage*, a light-draught turreted steamer, got aground in the Red River in April, 1864. She was attacked while in this position by a large force under the Confederate General Greene. His command was cut to pieces, and he was killed in the attempt to capture a monitor, vain even when it was hard and fast aground.

Of the iron-clads in the United States service, none were found of any value except the monitors. "I feel that we should have more of your vessels," wrote Mr. Fox, August 5, 1862, after the *Monitor* was in service and the ten vessels of the *Passaic* class, and the *Dictator* and *Puritan* were under contract:

Nothing that has been presented approaches them in value. The *Galena* and *Ironsides* are the work of the blacksmith; the *Monitor* a piece of delicate, perfect mechanism. Your associates have nearly five millions worth of work, and the public whom we serve expect other work to be scattered. For yourself, with your patriotic impulses, the establishment of your system must be your greatest reward. People incapable of making one of your ships are begging, beseeching, and demanding one. We propose to advertise, say for a class of vessels like the big monitor, Quintard's vessels, and the new monitors, to be built on the Atlantic or Western waters. Will you help us by furnishing drawings, etc., with the present royalty for the small ones, and say $10,000 each for the big vessels? I am most anxious to see monitors on the Mississippi; but there we must have double the boilers and two inches on the deck. You can do this and let us drive the rebels out of the river. Shall we advertise and rely upon you? This seems

the only way, since we cannot have the entire use of your brains, exclusively. I have thought over the matter deeply, and have come to the conclusion that your boats only can give us the Mississippi. If we say double boiler, two-inch deck, eight-inch turret, and five-inch side, can you give it to us in ten feet draught? If you say yes, we will go ahead at once, and the credit belongs entirely to you. Is there any possibility of night or Sunday work being thrown upon the monitors?

To this Ericsson promptly responded the next day, August 6th: "If you can allow *ten* feet of water draught it will be play to drive the rebels from the Mississippi. I have reference to iron vessels. Advertise as soon as you deem proper for more vessels and count on my assistance, pay or no pay." "We are taking as much night work out of our men as they can bear during this warm season," he added, in answer to the other question. "Unfortunately we cannot now, as formerly, resort to double gangs of men. Such is the pressure produced by the Government work that we cannot fill up our day gangs, much less the double system." This shows the difficulties under which he was himself laboring while undertaking to further assist the Government.

On August 8th, Fox replied: "Your answer is a loyal one, and such as I counted upon." He added various suggestions as to the character of the boats needed, concluding, "I rely upon your skill in all this matter, and leave you to turn over a six-foot gun-boat in your mind for all kind of shore and river work." The day this was received, August 9th, Ericsson was ready with his reply: "By Monday's mail [this was written Saturday] I will send you a general plan of a swift and powerful monitor ram for the Mississippi, of ten feet draught. Also a general specification that will enable you to advertise. While I am no advocate of surface condensation for fighting vessels running in salt water, I deem the distilling process indispensable for vessels navigating muddy rivers. I have long contended that the Mississippi will never be navigated safely and economically until surface condensation is resorted to."

Was it strange that the Navy Department should be disposed to repose entire confidence in a man of such ability and experience, and who could act with such promptness? The specifications for the boats required were indeed ready before

Ericsson's last letter was written, for they were dated October 8th, and were doubtless held a day or two for more careful consideration and the completion of the necessary calculations. The specifications provided for vessels of only six feet draught, 221 by 41 feet over all, with a flat-bottom iron hull 168 by 31 feet, encased in solid timber, shaped to the outlines of an ordinary vessel, with easy lines and extending 20 feet beyond the hull forward, and 32 feet aft. They were to carry three inches of armor, and were to have two propellers, with an engine for each, but with the shafts so coupled as to work together. The turret, pilot-house, etc., were to follow the model of the *Passaic*. These specifications were sent without charge or stipulation as to remuneration. How many men are there who can furnish detailed specifications sufficient to constitute the basis of a contract of a fleet of gun-boats on a novel plan at twenty-four hours' notice ?

The story of the "light-draught monitors," as they are called, is one of the most disgraceful chapters in the history of our naval administration. Twenty of them were built at a cost to the nation of $14,000,000. Had Ericsson's ideas concerning them been carried out, they would have swarmed up every Southern river and into every inlet and sound where six feet of water could be found, and would have exerted a most important influence upon the fortunes of the war. As it was, the money spent upon them was worse than wasted, for it led the Navy Department to trust to a scheme which proved abortive. Through mistakes and miscalculations by the Government officials in carrying out Ericsson's suggestions, the vessels were built with so little floative power that they could not be used for the purpose intended. As an attempt was made at the time to fix the responsibility for this enormous blunder upon Ericsson, it is due to his memory that the facts should be presented here.

We have already seen how promptly Ericsson responded to the request coming from the Navy Department, that he should furnish designs for the light-draught vessels it had determined to build. This was early in August, 1862. On February 21, 1863, Mr. Fox wrote, saying:

"The bids for the light-draughts are to be opened the 24th

inst. When I suggested these boats to you, I did not expect that you would be able to give time for the details, but I presumed you were to furnish the plans, leaving Stimers to work out your ideas. Before we contract I ought to know that this is so. From the beginning I have advocated the product of your brain and staked the reputation of the Navy on the result. Before launching off into the construction of these light-draughts you will tell me if they are all right, as we take them presuming them to be yours."

Ericsson at once telegraphed to Secretary Welles, February 24, 1863, "I have before me general plan of light-draught monitors. Permit me to say that the leading principle has been frittered away by changes." In this telegram he indicated some of the mistaken changes, and in a letter dated the same day he described these more in detail, and presented his reasons for objecting to the several alterations from his plan most clearly and forcibly. "I have not time," he concluded, "to enter further into detail, and much regret that I have only had a few hours to investigate a subject of great national importance. It will be well for Mr. Stimers to explain why he has not submitted to me his plans. Finding that this gentleman avoided to lay his drawings before me, and confined himself to some half-dozen questions during the whole period of preparing the plans, I arrived at the irresistible conclusion that he acted under instructions. This supposition I thought fully confirmed on learning that he had sent the final plan for the bidders to Washington, without affording me a chance of even looking at it. It was this persistent withholding of the plans from my sight which has forced me to adopt a course of extreme delicacy in relation to Mr. Stimers. These circumstances will explain the anomalous fact that I have not until this day seen the plan of the light-draught monitors which you have put into the hands of your contractors."

Burdened and harassed as he was, Ericsson resolved to leave nothing undone to save the Government from the disaster he saw impending, and which might still be averted, for the vessels were not yet under contract. Accordingly, on March 3, 1863, he telegraphed to the Secretary: "In connection with my associates in the *Dictator* and *Puritan* contract, I offer to

build six light-draught gunboats, according to plans and specifications now in your possession, dated October 8th of last year, for three hundred and seventy-five thousand dollars, each vessel. To be completed in four months, and to be two feet longer and two feet wider than stipulated in said specifications. Please state by telegram if you accept this offer. If you cannot do so, we respectfully withdraw our offer."

He proposed to deal directly with the Secretary or not at all. No time was to be lost, and he could not afford to submit to the usual experience of having his plans pottered over for weeks or months by Naval Bureaux, and then returned to him mangled out of shape and comeliness. This offer was not accepted, and I find no evidence that it was considered or answered. Nor was his urgent advice as to the character of the light-draughts heeded.

After waiting six weeks longer, on April 10th he wrote again to the Secretary of the Navy, saying: "Will you forgive me if I now, in a kindly spirit, point to a remarkable inconsistency on your part? You say you cannot confidently permit your contractors to put in the vacuum engines unless the work is done under my direction, and yet you are building a whole fleet of light-draught monitors, not only without my aid, but in opposition to my emphatic remonstrance. I tell you that your 22-inch cylinders are utterly incompetent to propel your boats, that your boilers prevent you from bracing the hulls, and that they will roast your engineers; and I predict that your vessels will break in two in a seaway for want of longitudinal strength; yet you have sufficient confidence in your contractors' assertion that they can make your vessels successful, while you cannot trust them to build the vacuum engines unless directed by the person whose judgment you practically ignore."

These protests against the completion of the light-draught monitors on a defective plan were unheeded. Doubtless they went through the usual routine of endorsement and transmittal from bureau to bureau, without reaching anyone who was sufficiently well informed to be impressed with their importance. Two influences were constant forces operating against Ericsson: one was the ignorant conceit of office; the other the political necessity of gratifying the incessant clamor for a distri-

bution of contracts over as wide a voting area as possible. As Ericsson, in his anxiety to have the work well done, had offered to build the boats himself, no doubt his criticisms were, according to the usual standard of interpretation, held to indicate a desire to secure a monopoly of the work for his associates and himself.

Whatever the reason, his letters and his telegrams to the Department were without effect. Contracts for twenty little monitors were prepared and distributed impartially over the country. Six went to Boston; three to Greenpoint, where was built the original *Monitor*, but to a different yard; two to Cincinnati, and two to St. Louis; Chester, Pa., Philadelphia, Pittsburg, Baltimore, and Camden, N. J., and Portland, Me., each had one. Thus the demand for the distribution of Government work to various sections was in a measure satisfied. The contracts were made generally in the spring of 1863, the last in June, and the vessels were to have been finished in the fall of that year. They were delayed, and as they approached completion in the following spring, Ericsson could no longer remain easy. Most emphatically he wrote to the Navy Department, and to Rear-Admiral Gregory, who had always shown the most friendly disposition toward him, and who was in command of the Brooklyn Navy Yard. There was now a prospect that the various evils he had predicted might be escaped; if in no other way, at least by the inability of the vessels to carry the weight to be put upon them, and that the outraged ocean would swallow up these bastard productions before they left their wharves.

"As Mr. Stimers is prosecuting the completion of his vessel," wrote Ericsson to the Admiral, May 16, 1864, "the Navy Department will very shortly be exposed to the deep disgrace before the country of one of its ironclads sinking at the wharf—a whole fleet of *similar vessels* being nearly ready! Stimers must be crazy not to see that his vessel will be under water at the stern even before stores are put on board. A person who applies a boiler weighing 140,000 pounds to operate two 22-inch cylinders, while boilers of less than *half* that weight give sufficient steam to supply a pair of 48-inch cylinders—witness many of our swift propeller vessels—I say, a person who

knows so little of his profession may be expected to blunder, but not to be actually blind, as appears to be the case with your Inspector."

Finding that the contractors for these vessels were being informed that he had been consulted in preparing the working plans, and determined that the Navy Department should not be again deceived, on March 30, 1864, Ericsson wrote to Secretary Welles, calling his attention to the letter of February 24, 1863, quoted above, and saying:

I have now respectfully to add, that I have not been consulted since, and that I had no precise knowledge of the nature of the mechanism and internal arrangement until about two weeks ago, when I obtained a copy of the engraved general plan which has been distributed among the contractors. I add with deep regret, that the inspection of that engraving forced the conviction on my mind that these vessels cannot succeed. The extraordinary complication of machinery and want of proportion of the structure in every part, is, I am compelled to say, a reproach to the profession. The liberality of the Department had placed at the service of Mr. Stimers an efficient staff, far more numerous than any I have ever known in similar undertakings. The working plans emanating from the Inspector's office have been executed in a style of finish I believe never equalled. Displacement and weight of parts have been calculated and recalculated at the Inspector's office, but alas, the vessels cannot carry the complex and cumbrous machinery put in, and if they could the motive power is insufficient to produce a speed sufficient for any practical purpose whatever. Had I not, in my letter of February 24, 1863, so emphatically expressed my disapprobation of the plan adopted, I should have felt it my duty ere this to have addressed the Department. It would ill become me to complain because my advice was disregarded, but I am forced to resist the attempt of the Inspector to fasten the responsibility on my shoulders for work executed from plans which I have not approved of and never seen.

It was speedily discovered that Ericsson was right. The *Chimo*, built at Boston under the immediate direction of Mr. Stimers himself, was finished. Instead of being out of water fifteen inches amidships, as was intended, she was only three inches above the water-line on an average—a miscalculation of twelve inches. This would not have been so serious in a vessel of the old style with high free-board, but in a monitor it was fatal. The Department immediately removed Mr. Stimers from the position of general superintendent, and placed the

question as to what should be done to remedy the difficulty occasioned by his error in the hands of Rear-Admiral Gregory and Chief-Engineer Wood, of the Navy. On hearing of their appointment, Captain Ericsson wrote, "I will cheerfully give Admiral Gregory any assistance he may desire in relation to the light-draught vessels. The handsome manner in which the Department has been pleased to recognize my services is a powerful incentive to renewed exertions in the great cause."

As conflicting instructions came from the Secretary of the Navy and his assistant, Mr. Fox, Ericsson wrote to Admiral Gregory: "I feel greatly honored by the confidence which the Secretary appears to place in my judgment, but I should not venture to give any directions excepting in accordance with positive instructions. Should the Department order you to lighten certain vessels, I will point out to Mr. Wood what I deem the best mode of doing it." Finally, the most complete authority was given to Ericsson to follow his own judgment in the matter, and Secretary Welles wrote, June 20, 1864: "The Department is not inclined to fix any conditions in regard to the alterations, but rather to leave the matter to your skill and experience. Economy of money and time are important elements of which you will probably feel the importance."

Admiral Dahlgren, who was in command of the South Atlantic station, and Acting Rear-Admiral S. P. Lee, commanding North Atlantic squadron, had asked that several monitors should be fitted out with torpedo arrangements and without turrets. It was accordingly decided that the five light-draughts most advanced toward completion should be fitted for this service, and that the sides of the others should be built up fifteen inches higher, as the roof of a house is raised when an additional half-story is added to it. Of course this would not bring them within the original requirements, but with eight feet draught they would have more capacity. The cost was increased about in proportion to this increase of space. Meanwhile, Ericsson most emphatically advised Admiral Gregory not to permit the vessels to leave the dock, as they would instantly sink if exposed to any undulating motion. The water-line being already six inches above the iron hull, there was a stream of

water pouring continuously into the vessel, and constant pumping was required to keep it down.

Mr. Stimers proposed to remove the overhang. As Ericsson had always insisted with such tenacity upon retaining this, the proposition excited his indignation and he wrote most emphatically to Admiral Gregory, calling attention to the fact that this would only put the vessel one inch more out of the water, and that the change would subject the rudders and the propellers, which were three feet out of water, to destruction by a twelve-pound shot, even at long range. "Would such a vessel," he pertinently asked, "be fit to explore rivers lined with rebel batteries?" "Pray, pardon my candor," he concluded, "but I can no longer remain silent on a subject that involves the interests of the nation and the reputation of the naval service."

With one-half her complement of coal on board, the *Tuxis*, another of these vessels, was only one and one-half inch out of water amidships, and the matter of discharging torpedoes from the deck of the vessel suggested grave difficulties. Nor was this the worst. On July 25th Ericsson wrote to Mr. Fox: "The mischief grows in magnitude with every day I reflect on the consequences. The mere raising the vessels is not what troubles me, but the fear that when done they will not possess the needed longitudinal strength actually deprives me of sleep at night. I hardly dare hope that in a heavy sea the structure will stand. I said to you in one of my letters that these vessels will 'break in two in a sea-way.' The only thing that has improved our chances since is that we now deepen the vessel's sides twenty-two inches, and I hope that will save us."

His letters not unnaturally contained some strong expressions concerning Stimers's capacity. "I forgot at the moment of writing you yesterday," he said to Mr. Fox, July 25, 1864, "that the man I stigmatized as a charlatan engineer is one of your subordinates, and that, therefore, you are his official protector. Nothing but excitement could make a military man for a moment forget so important a fact."

Surely it was an excitement over which even the angels might weep in sympathy, for, as Ericsson said in another letter: "That every blunder of Stimers falls upon me is of small account. It is our great cause which I have intently at heart,

which forces me to speak candidly to one who *has it in his power* to correct all."

The demand for the vessels, thus unfortunately misbuilt, was imperative, and on July 28, 1864, Mr. Fox wrote inquiring whether "the ingenuity and genius which have created the monitors could not remedy the blunders which are now known." The call became more and more urgent, and it was suggested that one of them, the *Tuxis*, might possibly be put in shape to do duty in the sounds of North Carolina.

Said Mr. Fox:

> A short history of the light-draught monitors is this: You furnished the original idea and sent it to the Department. Admiral Smith proposed the hollow chamber, and other suggestions were made, principally by Stimers; and as your hands and head were full, it was agreed to let Stimers prepare detailed plans, consulting with you so as not to get off the track. It was not known that Stimers was going off on his own responsibility, and through lack of information and his gross blunders, the Department has suffered in reputation, and the country has lost the services of these vessels. The Department will probably order Stimers on duty away from New York, and as a committee are to investigate the subject I would avoid a public controversy. The want of a light-draught iron-clad has been so imperative that the Department was justified in taking great risks to obtain one. The question now is not who is to blame, nor is it desirable to cuss or discuss. The only question is, what shall be done? It is an engineer's question alone, and I rely confidently upon you to solve it."

The *Tuxis* was finally put into shape to go into commission under Captain Henry Erben, U. S. Navy, and Mr. Stimers was ordered to her as engineer officer. When he reported on board he was confronted by an inscription on a plate set into the vessel, which declared that she was built by Reaney Son & Archibald, Chester, Pa., "from designs prepared by Alban C. Stimers, Chief Engineer of the United States Navy." Mr. Stimers was evidently not proud of this record, for he was discovered at work one day with a cold chisel cutting his name out of the plate. Had the vessel succeeded it would have stood.

Chief-Engineer Stimers had been associated with Ericsson in the construction of the original *Monitor*, and took passage in that vessel to Hampton Roads as a volunteer, at a time

when many of our engineers and constructors predicted that she would never be heard of again. It was owing to his zeal and skill, and his faith in Ericsson's conception, that all the engines of that vessel performed their functions during that memorable contest with the *Merrimac*, and from that field he was transferred to New York as general superintendent of iron-clads under construction. He had proved a most useful assistant, so long as he permitted himself to be guided by the instruction of the man who was so unquestionably his master in the art of naval construction. Ericsson had a well-defined and complete plan, and from this he was not to be moved by adverse criticism or well-meant advice. He could stand the united assaults of bureau disbelief and nautical complaint; Stimers could not, and he fell a victim to his zeal to improve upon Ericsson by piecing out what in his wisdom he regarded as an imperfect scheme, with the shreds and patches of nautical lore, such as the elder and the better constructor had rejected as inapplicable to his revolutionary design.

Though forced to condemn his work, Ericsson had no hostility to the man. He fully recognized the service he had done, and when Stimers died he exerted himself to procure from Congress for the benefit of his family the pension to which he believed him entitled. He educated his daughter, and most liberally responded to the call upon his good-will resulting from Mr. Stimers's early death. His letters to the Department were emphatic, as it was necessary they should be, but he refrained from public condemnation in spite of the fact that his friends urged that public exposure was necessary to his own vindication, and the circumstances were such as to provoke speech.

In a private letter to Mr. Fox, December 31, 1864, explaining the testimony he was called upon to give before a committee of Congress appointed to inquire into the matter, he said:

> Senator Wade and Mr. Odell called upon me last Tuesday, requesting me to give testimony with reference to the light-draught monitors. Accordingly, I met those gentlemen the following day at Astor House, and made a very full statement on all points which I deemed important. As I rendered only volunteer service without compensation, with no authority but an unofficial verbal request from the Assistant Secretary of the Navy—the receipt of my plans not even having been acknowledged

by the Department—I confined the testimony to what took place between myself and Mr. Stimers. The important deviations from my plan, introduced by him, were minutely pointed out and condemned; but full credit was given him on account of the fact that Mr. Isherwood had reduced the size of the steam cylinders and changed the form of boilers, full weight also being given to the circumstance that the water-box arrangement was deemed a great improvement and highly approved of by some of the ablest officers in the Navy. I also had occasion more than once to advert to the fact that the Department was led to believe that Mr. Stimers consulted with me and acted under my advice.

With his offer to build the vessels, Ericsson did send a working plan, constructed after a careful estimate of weights and displacements, and intended as a basis for the proposed contract. To this working plan no attention appears to have been paid.

Here are the facts, and certainly no chapter in the history of John Ericsson presents him in a better light. He might well have refused to take any part in helping the Government out of the serious difficulty into which it had been led by following other advice than his. He was heavily overweighted already, and a lesser man would have been occupied rather with the thought of his own triumph over those who had deliberately sought to deprive him of the honor due him, and to transfer his laurels to their own brows. But Ericsson had but one desire, and that was for the triumph of the cause with which his sympathies were enlisted; but one purpose—to assist to the utmost of his ability in extricating the Government from a difficult situation. So careful was he not to weigh his own reputation in the scale against it, that in a letter written to the press at the time, in response to current criticisms upon the monitors, his only allusion to the light-draughts was in this sentence: "The twenty light-draught turret vessels" [he would not call them monitors] "now in course of construction may cost, with improvements and alterations under the present enhanced price of labor and material, $500,000 apiece."

"You certainly must have had *very good reason*," wrote an anxious friend concerning this letter, "to speak of the light-draughts otherwise than to condemn and deny any connection with their construction. Why, an editorial has already ap-

peared in the *Tribune* assuming that you are their father! Sooner or later, the truth in relation to these monuments of stupidity must be given to the public. It may not be advisable for you to give any explanation at present, but you cannot carry the odium of publicly mentioning them without, at the same time, repudiating any connection with them."

No one understood the real facts better than the author of this letter, but he did not know how strong was the obligation upon Ericsson to refrain from complaint, not only to save the Government from criticism, but to spare Stimers, even at his own expense. He felt with Mr. Fox, who wrote: "I cannot be hard upon Stimers, who helped us in the first *Monitor* with so much zeal and courage. He has, however, given us a great set-back to what would otherwise have been success in everything."

How complete this disaster was is shown by this extract from the testimony given before the Naval Committee of the House of Representatives by one of Mr. Stimers's own corps, Alexander Henderson, Chief Engineer, U.S.N.

Question. Were those vessels known as "the light-draught monitors" ever used at all?

Answer. Some of them, I believe, attempted an existence, but it was a very brief one.

Ques. Were they not all failures, so that they could not carry their guns?

Ans. Totally and entirely, without an exception, so far as I know.

Ques. Were any of them of any value as naval ships in the navy?

Ans. Not of the slightest; and hardly valuable as old material. It would cost more to cut them up than they were worth. There was an attempt, I believe, to make use of them as torpedo boats, but they were so deficient in speed as to be hardly able to get out of their own way. I remember of one that came there, on the James River, without any turret, and she had a gun up; and the idea of an unprotected gun on the deck of a monitor was a new one to me at the time, and it made a forcible impression on me.

Change of occupation was Ericsson's play, and in spite of the enormous load upon him when he was devoting from twelve to fourteen hours a day to Government work, he found time to turn aside to commend to the President of the United States

the adoption of a repeating rifle. Had his advice concerning this been acted upon, not only would the Government have had an addition to the aggressive power during the war equivalent to a reinforcement of hundreds of thousands of men, but it would have been twenty years in advance of other nations in adopting this weapon, now in use in every modern army except that of the United States. Ericsson's letter is a most significant illustration of his quick apprehension of the military necessities of the time on sea and land which amounted to genius. "To His Excellency, Abraham Lincoln, President of the United States," he wrote, August 2, 1862:

SIR: I most respectfully call your attention to Mr. Rafael's repeating rifle. I have examined this formidable war instrument, and find it free from those imperfections which invariably defeat the usefulness of such contrivances. My long practical experience, together with my knowledge of military matters, enable me to judge with sufficient accuracy of the utility of this weapon. By its adoption the detached bodies of men necessary to retain possession of the places captured from the rebels, will at once be able to hold out against and defeat the concentrated force which the cunning enemy will, from time to time, hurl upon your small and necessarily isolated detachments.

The time has come, Mr. President, when our cause will have to be sustained not by numbers, but by superior weapons. By a proper application of mechanical devices alone will you be able with absolute certainty to destroy the enemies of the Union. Such is the inferiority of the Southern States in a mechanical point of view, that it is susceptible of demonstration that, if you apply our mechanical resources to the fullest extent, you can destroy the enemy without enlisting another man.

As a beginning you will do well to put into the hands of your exposed Western detachments the little war engine to which I have called your attention. One regiment of intelligent men provided with a hundred of these effective weapons, can most assuredly defeat and destroy a four-fold number of enemies.

Ericsson also found time to suggest to the Government a plan of flying artillery. Of this Fox wrote September 27, 1862, saying: "Blair* likes it much, and I have mentioned it to the Army Ordnance and the Assistant Secretary of War. It is pretty hard work to get anything started here, and I doubt if anything can be done unless it is proved. Blair thinks you

* General Frank P. Blair, brother-in-law of Mr. Fox.

had better make a set and prove how easily it can be accomplished, and I am inclined to press you upon the subject which I call monitors on shore; but you must recollect one thing—your brain is mortgaged to us to a certain extent. Think of the iron-clad, the six-footers, the *Puritan* and the *Dictator*. You are already carrying a terrible load, and I beg of you not to overtask it. I feel we are incomplete without the six-footers; the enemy will draw himself into his shell after the ten-footers have hammered him, and we can't get him out. I beg of you to look at this—20 feet for foreign nations; 10 feet for coast defence and harbor work; 6 feet for rivers. The series seem incomplete without them; I rely upon you and there are several shops ready to go into them."

CHAPTER XXI.

BATTLE RECORD OF THE MONITORS.

Evils of the Navy Bureau System.—Two Large Monitors Ordered.—The *Dictator* and the *Puritan*.—Poverty of the Government.—Pecuniary Embarrassments.—Application to Congress for Relief.—Interference with Ericsson's Work.—Handsome Acknowledgments of his Services.—The Monitors under Fire.—Attempts to Capture Charleston.—Dramatic Episodes of War.

AT the time of our great civil war the Navy suffered, as it suffered before, and as it still suffers in lesser measure, from what is known as the "Bureau System." It is an ingenious device for giving to incapacity, indifference, and stupidity the solemn sanction of official utterance; for reducing the pace of the swiftest to that of the slowest—the zeal, intelligence, and energy of the ablest to the capacity of the most sluggish in comprehension and the most inert in action. The building, equipping, and manning of naval vessels is entrusted to half a dozen independent bureau chiefs, a single incompetent or sluggish officer may thwart the most zealous efforts of his associates, and the plan of naval selection by survival, without regard to fitness, influences the choice of bureau officers, their appointment being usually limited to those who have grown old in the service, but not necessarily wise. The presence in the Navy Department of Mr. Fox, who had broken away from the influence of routine and tradition, served in a measure to correct the evils of a vicious system, but only in a measure. If he proposed, he must of necessity leave others to execute, and the result was delay and inaction where the circumstances imperatively demanded the utmost energy in performance.

It was on June 18, 1862, as we have seen, that Ericsson was informed by Mr. Fox that the Department had resolved to build two large monitors; it was not until August 8th that he finally

received authority to proceed with the work upon them. As his specifications for these vessels had been submitted to the Department on May 19, 1862, nearly three months had been occupied by the Naval Bureaus in moving the ponderous machinery of official cogitation to the point of action—a period only a little less than that in which Ericsson had planned a vessel of original and revolutionary type, executing the work in all its details, and sent it into action to startle the world with its achievement.

The *Dictator* was under way, indeed, nearly six weeks before her designer had proper authority for commencing her, and from this time on the history of his dealings with the Department concerning this vessel and her sister ship, the *Puritan*, is one weary record of delay and annoyance. At the time the original contract for these vessels was made, no practical knowledge had been obtained respecting turreted vessels, excepting from the brief experience of the original *Monitor*. Accordingly, the specifications of the contract rested mainly on the peculiar mechanism of that vessel. The *Passaic* class of armor-clads were tested in actual service some eight months after the date of the contract. Then, various defects were reported by the commanders of these vessels. These Ericsson was requested by the Department to correct, if possible. He was at the same time informed that all changes and improvements would be paid for, the Assistant Secretary sending word to the Government Inspector to "tell Ericsson we want all his improvements, and that we will pay liberally for the same."

This was sufficient for the zealous engineer, whose delight was in the perfection of his work rather than in the pay he received for it. It was not sufficient for his shrewd business associates. The suggestions for change multiplied so rapidly that they urged Ericsson to embody them in specifications to be submitted for formal approval by the Navy Department. A supplementary specification was prepared, and the amount of the additional outlay stipulated. This document, occupying sixty pages of foolscap, was presented to the Department, and not a single modification or improvement suggested; but when it came to payment, the prices were objected to and some items, "contrary to fact, justice, and common sense," as Ericsson justly

contended, were ruled out as forming part of the original contract. No allowance was made for the circumstance that prices were constantly changing at this war period, and that large advances in the cost of improvements occurred between the time of submitting the specifications for them and the actual ordering of the work.

Time was important, and under the continued expectation that the Department would formally approve what they had informally agreed to and ordered, Ericsson and his associates expended $650,000 on the vessels up to May 9, 1864, in excess of the payments by the Government. He could not go further with work not legally authorized, and which, as his experience with the *Princeton* showed, might never be paid for. He was compelled accordingly to notify the Department to that effect, calling their attention at the same time to the great increase in prices during the ten months occupied by the Department in cogitating upon his supplementary specifications before they were ready to act upon them. To Mr. Fox he wrote, July 27, 1864, saying: "Finishing the *Dictator* under the present enhanced prices is costly beyond my worst anticipations. We pay for many articles four times as much as they would have cost about the time we made the contract. I derive consolation from the reflection that when done the ship will be an honor to the country."

Not only was the expenditure in excess of the payments on account but a nominal payment by the Government in those days meant actually the issue of a Treasury warrant, and this must be sold at a discount to secure the means of meeting the daily demands for work and material. "The Government is so remiss in its payments," wrote one of the gentlemen whose business it was to discount such paper in July, 1864, "that almost everyone is losing confidence in its paper, and it is impossible to raise money on bills at any price; checks on the Sub-Treasury have of late been endorsed as 'good' on presentation, and the holders obliged to wait for an indefinite time. Contractors have offered three per cent. on their bills and have been refused. Unless there is a very marked improvement in our national and financial matters, we must decline taking any more Government bills from any party."

For a year Ericsson was kept in this state of suspense and perplexity by the inaction of the Department. For this, no doubt, adequate explanation was to be found in the embarrassments of the time. As early as July, 1863, he had been obliged to notify the contractors to stop work because of the "alarming position in which he was placed from the fact that the Chief of the Bureau of Construction" had not sanctioned changes ordered. One hundred thousand dollars had then been expended upon work not technically authorized, and disbursements were continuing at the rate of $5,000 each day.

Nine months later Ericsson reported to his friend Fox, that the work then done and for which he had received $1,634,365, could not be reproduced for $3,500,000. "I have done all that tact and perseverance can do to carry the work almost to completion, but now feel compelled to say that the immediate payment of eight and one-third per cent. of the reservation on the *Dictator* is indispensable." This payment was allowed and the reservation reduced from one-quarter to one-sixth of the amount of the contract. The reservation had been originally fixed by the Department at twenty per cent., and increased by Ericsson for some reason to twenty-five per cent., making a difference against himself by this change of $230,000 on the two ships, which in the end proved to be a serious matter.

This was a temporary relief, but not sufficient. By June 1, 1864, Ericsson and his associates were forced to notify the Department that they could go no farther with the *Dictator*, and that they must insist upon a new contract for the *Puritan* at increased prices, the old contract having been vacated by the changes and delays due to the action of the Department. This applied equally to the case of the *Dictator*, but as the work had already been done upon that vessel it was too late to insist upon this point. Up to that date, twenty-two months had been occupied in building the two vessels, and the outlay upon them in excess of receipts was $730,857, and $717,926 more was required to complete them. Deducting the amount still due from the Government, there would be a deficiency of $581,437, to be ultimately made good by Ericsson and his associates, while meantime they were required to advance $1,447,883 before receiving payment from the Government of

any part of this large sum. Had they been suffered to carry out the contract as originally agreed to, without alteration or suggestion of improvement or change, the vessels would have long before been completed, and at a profit to the associates.

A conference was arranged in Washington between Ericsson's three associates, Messrs. Winslow, Griswold and Bushnell, and the Secretary, Assistant Secretary, and the Chief of the Bureau of Construction, Mr. Lenthall. "At our intimation that we should not deliver the *Dictator* or go on with the *Puritan*, they did not seem startled," reported Mr. Winslow, "but rather received the announcement as natural and proper; and while emphasizing the utter inability of the Department to make any increased allowance upon the contract or to make a new and amended contract for the want of authority, yet they conceded we ought to have all we asked, and if we would apply to Congress for it, the Department would aid us by direct recommendation in its favor."

Application was accordingly made to Mr. Hale, Chairman of the Senate Naval Committee. Mr. Winslow confessed to having exerted considerable diplomacy in convincing him, as he was "averse to doing anything which he suspected might not be in harmony with the wishes of the Department." The merits of the case were apparent, and Senator Hale took prompt action. A resolution was prepared that evening, presented to Mr. Hale the next day, and favorably acted upon by the Senate on the following day, and a month later had finally passed the two houses of Congress. This resolution required the completion of the *Dictator* under the existing contract, but authorized the payment for the less advanced *Puritan* at its "present value as far as completed," and the value of the material on hand "deemed actually necessary to her construction." This value was to be determined by a Board and the vessel was to be completed by the Government.

In a letter addressed to Senator Hale, in support of the memorial of Ericsson, Secretary Welles described the monitors as having rendered invaluable service to the country through "their great strength, wonderful capability of endurance, power of resistance, and efficiency," all of which have been "abundantly proven." They were described as vessels "that could

and would in conflict overcome the most formidable armored ships afloat." So far as the work on the *Dictator* and *Puritan* was completed, Mr. Welles said:

It is but justice to say that it is in all respects creditable to the memorialist and satisfactory to the Department. That the memorialist and his associates or sub-contractors are liable and likely to sustain loss on the vast expenditure that has been made under the original contract is not questioned. The Department, knowing the embarrassments attending this great outlay, has extended its favorable consideration to this case. The work was novel, unanticipated delays intervened, great changes have taken place in our monetary concerns, affecting prices and every business interest, for none of which, however, was this Department responsible, and could therefore afford no relief. The case is one that presents itself to Congress for fair and liberal consideration. The memorialist has been a public benefactor, and in the fulness of his patriotic zeal has freely given to his country the productions of his genius and the labors of a remarkable mind. In doing this, and in undertaking to furnish the Government with vessels that would give it maritime supremacy, he does not appear to have been influenced by pecuniary motives. His work has been well done, and is worthy of the Government and country. Machinery to execute his contract has to some extent had to be made by the memorialist in order to construct his vessels, which are themselves novel in naval architecture. These and other causes, partly at least governmental, contribute to make his case an unusual one.

This was the sentiment of the Secretary and of his Assistant. Handsome as was this acknowledgment of the services of Ericsson, it did not relieve him from the consequences of the illiberality of the Bureaus in passing upon his contract. "Notwithstanding the positive recommendation of Admiral Gregory to pay the whole amount claimed," he wrote to Senator Hale, "and notwithstanding the award in my favor of two separate boards of naval officers and engineers, more than one-third of the work enumerated in my supplemental specification for extra work has been ruled out by the Department under the assumption (most erroneous in my humble opinion) that it formed part of the contract. Nor is this all, for the prices in my supplemental specification were fixed a year ago, since which an increase of thirty per cent. on labor and material has taken place."

Thus it would appear that Ericsson's difficulties with the

Dictator and *Puritan* were the result partly of his professional anxiety to make his work complete, which led him to too confident a reliance upon unofficial promises of reimbursement for his increased outlay; partly to the peculiar conditions of the times; but chiefly to the difficulty of accomplishing anything through the cumbersome machinery of Boards and Bureaus. Government used plans it never paid him for to build vessels in competition with him in the same ship-yards, and to compete with him for labor and material in markets depleted in a measure of supplies by the enormous demands of war, and of labor by the temptations offered for enlistment.

Even the draft ordered in 1863, to fill the thinned ranks of the Army, came in to threaten him and others with the further deprivation of workmen compelled to respond to an enforced demand for military service. This obliged him to appeal to the Government to exempt the men engaged upon Government work from the obligations of the conscription. In support of his appeal he urged that exemption from military service for men employed on the national vessels would infuse new life into the building yards, attracting to them skilful and good workmen in great numbers. "A man drafted to pursue rebels or dig trenches, does not," he contended, "contribute more effectually to the defence of the nation than the toiling laborer who heats and clenches the rivets of the armor intended to resist hostile shot."

A million and a half of men had by this time been called into the military service of the United States, and, making all allowance for re-enlistments, much over one million had been actually taken from the industries of the North, besides the army of those engaged in the vast system of industries immediately connected with the supply and transportation of troops. Finances were disordered, and prices of material subjected to the most rapid fluctuations, as the sensitive pulses of traffic beat responsive to the good or evil fortune of capricious war. More than a thousand engagements of greater or lesser moment were already on the record, and still we had not reached the skirmish known as that of the "Devil's Back Bone," which stands midway between engagement No. 1, the "Assault on Fort Sumter," on April 12, 1861, and engagement No. 2,261, the "Sur-

render of Kirby Smith," a little more than four years later, which is officially declared to have ended the war. It was thus at the very high tide of military contention and business disturbance that Ericsson was called upon to do his heaviest work for the Government.

When the "big vessels," as they were called, were first projected, the Department considered the advisability of building three or four. Mr. Fox thought there should be four, and wrote to ask whether this number could not be built for a million of dollars each; Ericsson replied most emphatically that it was impossible to build them for less than the price named. This was $1,150,000 for each. He added that to build them for this price it was necessary that detailed working plans should be furnished at once for every part of the vessel and machinery, to enable manufacturers to estimate the cost with perfect accuracy and to start the work right away. Everyone can understand the embarrassment a contractor was subjected to who was exposed to constant delays and changes under the conditions of a rising market. Good work Ericsson would have at any price. To one of his sub-contractors he wrote: "If the enforcement of good, honest, accurate work is likely to produce what you know as 'a row' under your present foreman, you will do well at once to make a change."

When we recall the shameful waste of money, and the melancholy loss of life, resulting during our great war from the ignorant or dishonest neglect of the obligations of public duty, the record of John Ericsson as a contractor shines out like a star from the gloom of night. In a circular dated "Navy Department, December 24, 1864," Secretary Gideon Welles said: "The lives of our brave men and the honor of the flag are bound up in a rigid inspection of all our iron contracts, and yet there is not a single instance known where a superintending engineer has held a contractor through every step of his work to an exact compliance with every specification of his contract." "An engineer of approved integrity and rigid and critical ability," Chief Engineer J. W. King, U.S.N., was accordingly appointed to examine all contract iron work in progress. The next year he reported on thirty different establishments, especially commending the work of two contractors. These two were the

Corlies Engine Co., and John Ericsson. Of the work of the engines and boilers of the *Madawaska*, built at the Allaire works under the direction of Ericsson, Mr. King said, "The workmanship throughout on all the boilers is first class and the material sound, so far as can be seen. The iron was not tested, because no pieces could be found from which the shells were made." Altogether, Mr. King examined 245 marine boilers in different parts of the country.

During the civil war, $61,781,684 were spent on the hulls and engines of 121 vessels which had to be condemned and broken up within a short time, all of them having disappeared from the naval list within the next twelve or thirteen years, leaving as their relics only a half a dozen sets of machinery stored at Navy Yards. Thirty of these vessels never did a day's service. Nine of them, besides the wretched light-draught monitors, were condemned on the stocks, or before they went into commission. Altogether, nearly eighteen millions of dollars were expended upon vessels utterly worthless from the beginning. In addition, four and a half million of dollars were wasted in building engines for nine ships which were never built nor even started. These vessels, be it remembered, were not ordered merely for war purposes, but for durability and to furnish a permanent increase to the Navy. Some of them rotted on the stocks before they were launched.*

Following its encounter with the *Merrimac*, the original *Monitor* was sent up the James River, with the iron-clad *Galena* and several wooden vessels, to make a demonstration against Richmond. This, says Professor Soley, was "one of the boldest and best conducted operations of the war, and one of which very little notice has been taken. Had Commander Rodgers been supported by a few brigades, landed at City Point or above on the south side, Richmond would have been evacuated. The *Virginia's* crew alone barred his way to Richmond; otherwise the obstructions would not have prevented his steaming up to the city, which would have been as much at his mercy as was New Orleans before the fleet of Farragut" ("Battles and Leaders of the Civil War," p. 761).

It was the first time that the *Monitor* had been subjected

* See Testimony before Committee on Naval Affairs. 1879.

to the fire of forts, and Rodgers reported that she "could not have done better." Thirteen shot and shell perforated the side of the *Galena*, killing thirteen men and wounding eleven with fragments of her own iron. There were no casualties on the *Monitor* and she was struck but three times, no damage being done. Being asked his opinion as to the danger of piercing the decks by the plunging fire from the forts, Ericsson replied that there was no danger. "Much is feared," he said, "from plunging fire by those who only look up to the top of a hill without estimating the relative proportions of base and altitude. It very seldom happens that batteries are high enough to give an effective plunging fire. In the Crimea there were a few instances of effective plunging shot."

Still, Ericsson was the victim of no delusions concerning his vessels, and as we have seen, he did not share the enthusiastic belief of some of his admirers that they could be effectually used in an open attack against forts.* As early as September 30, 1862, he wrote to Mr. Fox: "I strongly urged Mr. Stimers yesterday to impress you with the fact that the number of fifteen-inch guns, rather than the number of vessels, will decide your success against the stone forts."

The Southern city of Charleston was at this time occupying the attention of the Navy Department, and on April 10, 1863, he wrote with reference to the use of the monitors in the naval attack, saying:

> I candidly confess that I cannot share in your confidence relative to the capture of Charleston. I am so much in the habit of estimating force and resistance that I cannot feel sanguine of success. If you do succeed, it will not be a mechanical consequence of your "marvellous" vessels, but because you are marvellously fortunate. The most *I* dare hope is, that the contest will end without the loss of that prestige which your iron-clads have conferred on the nation abroad. If armed with proper guns, I believe your seven turret-vessels, now before Charleston, would destroy the whole present fleet of England. A single shot

* Ten years after the war Ericsson wrote, saying: "In reply to your kind letter asking for a copy of 'acknowledgments received complimentary to what you are pleased to call my 'great work,' I beg to state that nothing could induce me to lay before the world the approving opinions of the monitor system without also presenting the adverse criticisms of my work which learned as well as skilful, practical men have written in great numbers.'"

will sink a ship, while a hundred rounds cannot silence a fort, as you have proved on the Ogeechee. The immutable laws of force and resistance do not favor your enterprise. Chance therefore can only save you. I am much pleased to learn that you intend to visit New York, but hope you will not wait until the "Charleston matter is settled."

Could anything be clearer than this? Could any judgment be freer from the bias of prejudice in favor of one's own creations than Ericsson showed his to be in this particular instance? If he did not believe the monitors could subdue forts, attacking them by day, he did believe that they would have great advantages in an attack by night. As he also believed that they could with impunity run by fortifications, however heavily armed, if they had an unobstructed channel, his efforts were directed to devising some means of clearing the way for them into Charleston harbor. To Fox he wrote (October 24, 1862):

Mr. Stimers has mentioned to me the subject of the removal of the obstruction in the harbor of a certain Southern city. As the problem is an old one in military science, I am not quite unprepared to advise in the matter. The removal of piles by the process of explosion is a very tedious one, and nearly impracticable under the enemy's guns. The explosion of powder under water is quite local, its effect being remarkably limited, owing to the incompressible nature and great specific gravity of water. Should you be correct in your supposition that piles form the chief obstruction, we can make short work of it by ploughing a channel through it by means of a deep iron-bound raft pushed by one of our monitors, the process being a continuous butting and backing. This operation can be carried on quite well during the darkness of night by mooring two vessels in line with the desired channel. The butting vessel by taking back sight can, in this way, operate accurately in any given line. I shall be very happy to contrive the butting raft of such a form as to suit the bow of our vessels without straining the same during the heavy butting operation.

Ericsson's belief in the possibilities of a night attack upon Charleston is confirmed by that of P. G. T. Beauregard, the best Confederate authority on this subject. Writing to the *Philadelphia Weekly Times* in October, 1877, General Beauregard said:

It is pertinent for me, professionally, to remark that, had the Federal naval attack on Fort Sumter of April 6, 1863, been made at night,

while the fleet could easily have approached near enough to see the fort—a large, lofty object, covering several acres—the monitors, which were relatively so small and low on the water, could not have been seen from the fort. It would have been impossible, therefore, for the latter to have returned, with any accuracy, the fire of the fleet, and this plan of attack could have been repeated every night until the walls of the fort should have crumbled under the enormous missiles which made holes two and a half feet deep in the walls, and shattered the latter in an alarming manner. I could not then have repaired during the day the damages of the night, and I am confident now, as I was then, that Fort Sumter, if thus attacked, must have been disabled and silenced in a few days. Such a result, at that time, would have been necessarily followed by the evacuation of Morris and Sullivan Islands, and soon after of Charleston itself, for I had not yet had time to complete and arm the system of works, including James Island and the inner harbor, which enabled us, six months later, to bid defiance to Admiral Dahlgren's powerful fleet and Gillmore's strong land forces.

In a letter enclosing this to Ericsson, Captain Fox said: "This confirms all you said at the time, and justifies the Department in its course then pursued, though we were obliged to differ with one of our great admirals" (Du Pont). In his account of the military operations of General Beauregard, his aid-de-camp, Alfred Roman, repeats this statement more in detail, saying:

"What General Beauregard apprehended most was a night attack by the Federal monitors and iron-clads. During a dark night nothing could prevent them taking a position sufficiently near Fort Sumter, and there opening fire upon it with almost certain impunity. By repeating the manœuvre several nights in succession, they might eventually batter down the walls of the fort and dismount most of its guns, or blow up its magazines. It was evident that Sumter, being a large object, could be seen well enough to be fired at with approximate precision, even at night; while the monitors, being small, and lying low in the water, would hardly be discernible from the fort, and, if made to change their positions after each discharge, might render impossible any accuracy of aim on the part of our gunners, who would be left with nothing else to guide them but the flash of the enemy's pieces. And General Beauregard was of the opinion that, by establishing floating lights of different

colors at the entrance of the various channels leading into the inner harbor, and by frequent soundings, rendered easy by most excellent coast-survey maps in the possession of the Federal commanders, the plan of attack just described could have been carried out with no serious difficulty, and to the advantage of the enemy, especially if undertaken while the tides were stationary, or nearly so. Fortunately, however, Admiral Du Pont, and the other naval commanders having charge of the hostile fleet, did not attempt this simple mode of attack, against which the guns of Sumter and of the works around the harbor would have been almost powerless." *

The rafts suggested by Ericsson were prepared and sent to Charleston, where one of them was attached to the monitor *Weehawken*—leading the advance in the attack of April 7, 1863. The commander of the *Weehawken* reported saying: "No vessel could carry it except in smooth water. Its motions did not correspond to the movements of the *Weehawken*. Sometimes when she rose to the sea the raft fell, and the reverse. Thus we were threatened with having it on our decks under the overhang. No prudent man would carry the torpedo attached to the raft in a fleet; an accidental collision would blow up his own friend, and he would be more dreaded than an enemy."

Ericsson, who did not accept this conclusion, wrote to Mr. Fox: "Our naval operations at Charleston are conducted in a manner calculated to work great mischief. It is truly unfortunate that your original plan of breaking up the obstructions and running past the forts has not been carried out. It is now evident that, unless you order the rafts to be employed at once, the prestige of the monitor system will receive a fatal blow. Any broadside vessel covered with four-inch plating and armed with eleven-inch *shell* guns will beat the whole monitor fleet out of sight at shelling forts. Yet a monitor, with her fifteen-inch solid shot could sink such broadside vessel to the bottom in ten minutes. I trust, sir, that you will interpose your strong arm and at once order the monitors to be pushed straight up against the rebel obstructions, armed with the rafts and bottom scrapers. The reluctance to employ the rafts amazes

* Military Operations of Gen. Beauregard, by Alfred Roman, vol. ii., p. 62.

me, as the perfect safety against the enemy's torpedoes insured by the bottom scrapers is self-evident."

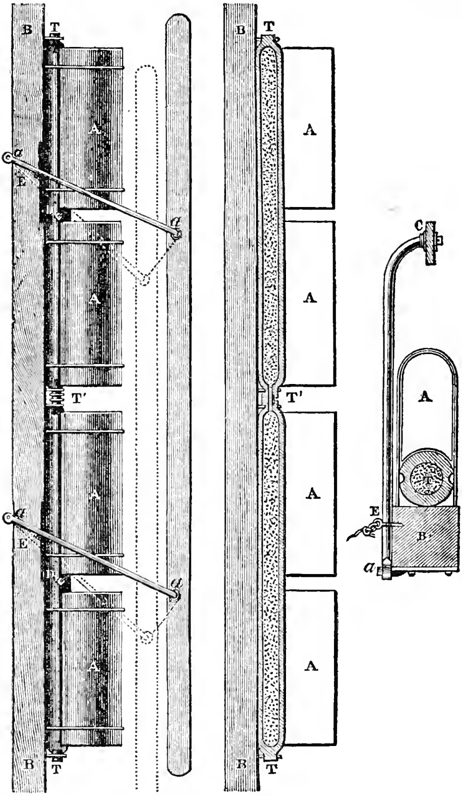
Again, a month later, he wrote:

"That your rafts with their thirty-feet shells—if an adequate number be exploded—will remove the obstructions, there can be no doubt; but I foresee certain destruction to the monitors, with their *unprotected propellers*, when the vessels reach the inner harbor. I need not remind you of what you have so often pointed out, viz., that the most insignificant obstructions may entangle the propeller and thereby render the vessel helpless." The shells referred to were thirty feet long, weighed over six thousand pounds, and carried a charge of seven hundred pounds of powder. In preliminary experiments with them it was found that they subjected the raft to no danger, as the explosive force acted forward.

The Obstruction Remover, or "boot-jack," as the sailors called it, was designed to clear the channel of all obstacles interfering with the passage of a vessel, including torpedoes, fixed or floating, and electric torpedoes at anchor. It was a raft, fastened in front of an advancing vessel, and carrying torpedoes so arranged as to be fired upon contact with an obstruction, the force of the explosion being thrown forward by placing air-chambers in front of the torpedoes, so that the resistance was less in that direction than any other. The diagrams on pages 50 and 56 show the nature of this contrivance.

To the son of the Admiral who succeeded Du Pont in command, Dahlgren, Ericsson wrote, January 18, 1864:

I note particularly what you say of the ability of a dozen monitors to take Charleston. I cannot agree with you. My opinion is that if the Admiral should rashly bring his dozen turret-vessels into the fire of the batteries of the inner harbor, among the numerous entangling obstructions, he will be compelled to leave half the number behind, and come out without having taken Charleston. Has it not been fully established that you cannot silence a single small fort? Why, then, imagine that you can destroy a series of fortifications; ingenious constructions to afford perfect protection to their defenders, your destroyers? Admiral Dahlgren has already achieved his greatest triumph at Charleston by shutting up the port. He has earned the lasting gratitude of the nation by this act and damaged the rebellion to an incalculable extent. His merit will be acknowledged in due season, and the good use



Explosive Apparatus of the Obstruction Remover. Plan and Cross-section.

T, T', T, Explosive apparatus formed of two cast-iron shells, each 11½ feet long by 10 inches in diameter, charged with 350 pounds of No. 7 powder, the two being united in T' by means of a water-tight joint. A, A, A, A, Copper air-chambers fitted to the front of the torpedo in order to direct the force of the explosion forward. B, B, Square timbers to which the torpedoes and the air-chambers are fastened. C, C, Trigger-board placed parallel to the beam B, B, and attached to it by the rods a, a, which act upon the percussion fuses when the trigger-board strikes an obstacle. D, D, Triggers connecting with the percussion fuses in the torpedoes. E, E, Safety-pins which are removed at the proper moment.

he has made of the *Monitor* has already paid the cost many times over. It will greatly add to your father's reputation that a grand naval hero, his predecessor, declared the *Monitor* inadequate to the service which, under your father's skilful direction, has been so successfully performed.

Admiral Dahlgren himself was more sanguine, for he wrote seven months later than this, from off Charleston (August 4, 1864):

The positive evidence here in favor of the monitors is very plain—what has not been done with them amounts to nothing against them. I do not object to fight forts with them—nor even forts, iron-clads, and obstructions combined, as here—but should like enough monitors to make sure of a useful result, and not hazard interests more important than even Charleston, which a disaster to the only iron-clad fleet of the Union would have insured.

The monitor *Tecumseh*, lost in Admiral Farragut's attack upon Mobile, August 5, 1864, was the victim neither of forts nor iron-clads, but of a torpedo which she ran against owing to the neglect of her commanding officer, Captain T. A. Craven, to keep to the channel he was ordered to follow. Describing this occurrence, a distinguished officer of the U. S. Navy, Captain Foxhall A. Parker, in his "Battle of Mobile Bay," pp. 13 and 26, said:

The morale of the Union fleet then was what the French would call superb; all, from the highest to the lowest, placing implicit faith in Farragut, and all prepared to take any risks when led by him. Thus, while the Captain of the *Winnebago* was coolly walking back and forth on the bridge of his vessel, giving orders first to the gunners of one turret, then to those of the other, how to direct their fire, a negro seaman, probably stationed at the life-buoy, was as coolly promenading the poop-deck of the *Galena*. Seemingly unconscious of all that was passing around him, this man, with his hands uplifted to heaven, was loudly singing a negro hymn. God knows what thoughts were passing through his mind on this his day of jubilee!

At this moment, when the eyes of all were riveted on the iron-clads, expecting to see them hotly engaged as soon as the *Tecumseh* should have passed the lines of torpedoes intervening between them, the *Brooklyn* and the *Hartford* poured a broadside into Fort Morgan,

driving the enemy helter-skelter from their barbette and water-batteries.

The sight was an inspiriting one, and, in the enthusiasm of the moment, the gallant Craven, who thirsted for the honor of engaging the ram singly, gave the fatal order, Hard a-starboard! and dashed straight at her, his course taking him to the westward of the large red buoy. The bow gun of the *Tennessee*, loaded with a steel bolt weighing 140 pounds, was kept steadily trained upon the monitor as she advanced.

"Do not fire, Mr. Wharton," cried Captain Johnston, of the *Tennessee*, "until the vessels are in actual contact."

"Aye, aye, sir," was the cool response of Wharton, as he stepped to the breech of the bow gun, in expectation of a deadly fight at close quarters.

Scarce were the words uttered when the *Tecumseh*, reeling to port as from an earthquake shock, foundered, head foremost, with almost every soul on board, destroyed by a torpedo. A few of her crew were observed to leap wildly from her turret; for an instant her screw was seen revolving in air—and then there was nothing left to show that the *Tecumseh* had ever formed one of that proud Union fleet, but a small boat washed from her deck, and a number of half-drowned men struggling fiercely for life in the seething waters which had closed over their vessel forever.

Such was the fate of the *Tecumseh!*

Short shrift had they who went down with her! Yet, short as the time of her foundering was, it has furnished us with one of those magnificent episodes of war which make famous the annals of nations.

Craven and Mr. John Collins, the pilot of the *Tecumseh*, met, as their vessel was sinking beneath them, at the foot of the ladder leading to the top of the turret.

Great and good men often err; but they differ from ordinary mortals in this, that they are willing to atone for their errors even with their lives, if necessary. It may be, then, that Craven, in the nobility of his soul, for all know he was one of nature's noblemen; it may be, I say, that in the nobility of his soul, the thought flashed across him that it was through no fault of his pilot that the *Tecumseh* was in this peril; he drew back. "After you, pilot," said he grandly.

"There was nothing after me," relates Mr. Collins, who fortunately lived to tell this tale of heroism; "when I reached the utmost round of the ladder, the vessel seemed to drop from under me."

Yet Craven's words, carried to heaven by approving angels as evidence of man's humanity to man, will live forever in the book of life, with no tear on the page to efface the record. Therefore, the navy points with exultation—not regret—to the buoy off Fort Morgan, which watches over his iron tomb.

When the *Tecumseh* went down, the crew of the *Hartford* sprang upon her starboard hammock rail, and gave three loud, defiant cheers.

This cheering was mistaken by the crew of the vessels following the *Hartford*, as an indication of some advantage gained over the enemy, and taken up by them in succession.

"Admiral Farragut now admits," said Ericsson, referring to this engagement, "that a single monitor can sink a whole fleet of wooden vessels. He was convinced after seeing his own gun-deck covered with blood and mangled bodies by the fire from the ram, while on board the turret-vessels not so much blood was shed as a mosquito could draw."

CHAPTER XXII.

THE MONITOR VERSUS THE BATTLE-SHIP.

The Controversy over the Monitor.—Its Influence upon Naval Construction.—The Tests of Battle.—The Port-Stopper and Balanced Rudder.—Ericsson's Ability as a Writer.—Sailor Characteristics.—Opposition of Admiral Du Pont, Captain Percival Drayton, and others.—Monitors as Sea-boats.—Engineering Ignorance.—Ericsson's Sea-lead.

THE controversy started by the advent of the monitor has not yet fought itself out, but many of the arguments and some of the prejudices arrayed against Ericsson in the beginning have been eliminated from it. He was required, first to establish the superiority of the armored to the unarmored vessel for the purposes of war, and next to defend a peculiar and, from the nautical point of view, most obnoxious system of armored construction, against assaults, prompted not only by objections to the system itself, but by crudities in its early examples which gave just occasion for offence. The deficiencies in motive power, in guns, in armor plate and other material, gathered in haste and put together by inferior workmen unfamiliar with their tasks—all these counted against him in the public, as well as in the professional, estimate of the value of his system. The ignorance of the engineers and firemen, to whom the management of these novel structures was assigned, and the inability of naval officers, trained in a different school, to at once adapt themselves to new conditions—all were urged as effective arguments for the adoption of some other form of armored battle-ship; precisely what form no one knew then, no one knows now, so far as agreement of professional opinion is to be accepted as a guide to knowledge.

The tendency of naval sentiment is, as it always must be, to the combination in a single vessel of incompatible conditions.

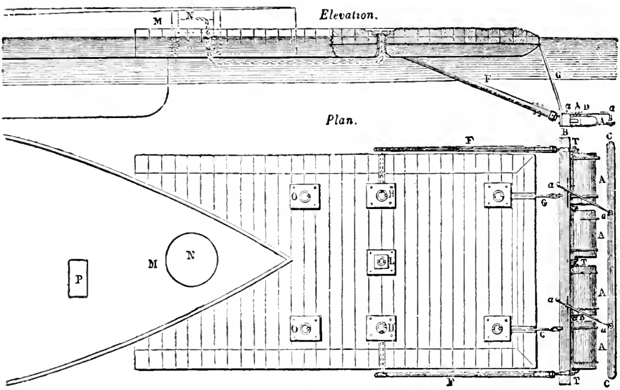
For speed we must have engine-room and coal capacity; for offence, enormous guns; for defence, heavy armor; for the comfort of officers and crew, ample space for wardroom, steerage quarters and berth decks. To combine these in a single vessel, and to add the necessary "top hamper" to admit of carrying sail in the event of a temporary loss of engine power, calls for such a craft as never yet sailed the sea. There must be compromise somewhere, and the warring factions are still disputing as to what is to be insisted upon as most essential. If in times of peace the claims of comfort, of dignity, and display have the first place in naval regard, in war the factors of offence and defence become the dominating ones. Naval officers have much the same objection to living in a monitor that a knight of old may be supposed to have had to eating and sleeping in his armor. It is for the fight only.

Ericsson dealt with the question from the point of view of the engineer, and he always insisted that his monitors were not meant to be vessels in the strictly nautical sense, but floating batteries. He strove to combine the maximum of offence and defence by reducing the area of the floating surface he was required to cover and the number of guns he was expected to protect; concentrating a given weight of metal in a few large pieces, and adding to their aggressive force by enlarging the area of their fire from an arc of a few degrees to the complete circle of three hundred and sixty degrees.

The extent to which these ideas have influenced modern naval construction can be seen by examining the armor-clads of any naval power. Ericsson further added complete protection for his anchor, rudder, and propeller by his contrivance of an overhang, discarding, as we have seen, the forward overhang in his later vessels in deference to naval demands. It will be time enough to say how far the features considered by him as essential to his system can be modified or dispensed with, when vessels of later construction are subjected to such a test of battle as his monitors endured.

The protection given by the rear overhang to the propeller was so complete that not one of the 1,030 hits received by the *Passaic* class of monitors injured this part of the vessel. The forward overhang gave equal protection to the anchor, and

this could be raised and lowered without the enemy knowing whether or not the vessel was swinging at her anchor. The overhang, no doubt, interfered with the speed of the vessel, but it was in no danger of being torn away by the upward action of the water underneath it, as the monitor rose and fell with the waves. This effect was less upon the submerged overhang than upon the over-hanging paddle-boxes of an ocean steamer. The central idea of the monitor was impregna-



Obstruction Remover of Captain Ericsson.

F, F, Booms of the explosive apparatus. G, G, Cords for lowering and raising the apparatus so as to fix it at a proper depth below the surface of the water. H, H, Three circular openings in the raft through which were passed the chains controlling the ends of the booms F, F. K, Raft with the rear cut out so as to fit the end of a monitor. M, Bow and overhang of the vessel. N, Anchor-well of the monitor. O, O, Rings for fastening the raft and holding in a fixed position. P, Anchor-well. The description of the other diagram also applies to this one.

bility. "I promised the Government in 1861," said Ericsson, "to keep out Confederate shots and kept my promise. In no case was the side-armor or turret pierced." The port-holes of the turrets were closed by a heavy mass of iron, jointed above and below, so that it could be turned half around to clear the port and back again to close it. Concerning this "port-stopper," as it was called, Ericsson said: "I contemplate this simple device with more satisfaction than almost any on that tolerably extensive catalogue of inventions which pro-

tracted labor has produced. The designing of an efficient port-stopper, not liable to derangement, has long been considered by artillerists and military engineers as an idle dream of schemers who know nothing about the force of projectiles. The value of the turret system with its few guns is not only enhanced, but doubled, by the absolute protection which this mechanical device gives to the armament and crew. As the guns are pointed without looking through the ports, the port-stopper is only opened when the gun is to be discharged, and again closes the instant the gun recoils."

In a communication to the *Army and Navy Journal*, November 7, 1867, Ericsson said:

> The fact that the projectiles of our opponents during the late conflict did not, in a single instance, strike the port-stoppers of the turrets, furnishes the best argument in favor of the plan insisted upon by the constructor. It is singular that, while our gallant sailors during the war frequently appeared on the decks of the monitors within range of the enemy's fire, they never seemed satisfied, when inside, unless they were hermetically sealed up.

Another feature of the monitors was the balanced rudder, and this was introduced by Sir E. Reed, Chief Constructor of the British Navy, on H. M. S. *Bellerophon* in 1863. Mr. Reed having been accused of copying it without credit, said in reply, in a letter addressed to John Bourne:

" So far have I been from copying the balanced rudder unacknowledged, that the fact of its having been largely used by Mr. Ericsson in his monitors, with success, was my strongest reason for pressing for permission to apply it to the *Bellerophon* and has throughout been my strongest justification for using it. I have always said, and always wish it to be said, that the general adoption of the balanced rudder by Mr. Ericsson was a very scientific and bold affair, and that I doubt if my own boldness in the matter (in applying it for the first time in our navy to a ship of more than 4,000 tons) would have been approved or allowed to take effect, if I had not had Mr. Ericsson's confident and successful example to appeal to."

In response to a statement by an officer of the British Navy in 1865, that it was an old English invention, Ericsson

said: "I myself made it old by applying the balanced rudder to steamers in England for the first time in 1834—thirty-one years ago." When he found that it was to be appropriated in England without credit, he applied for a patent for it there. "There is no question about the balance rudder acting as a drag," he said, "yet such are its advantages in point of steering steamships with single propellers that its employment is proper."

The relative efficiency of monitors and other armored vessels was fully tested during our war. Whenever the trial came the monitor type most signally vindicated itself; and some of the most striking and dramatic episodes of the war are connected with its history. Summing up the record, Ericsson said:

"Captain Worden, commanding the *Montauk* (*Passaic* class), discovered, February 28, 1863, the Confederate corsair *Nashville* in the Ogeechee River, Georgia, near Fort McAllister, watching an opportunity to slip out to sea past the Union fleet. The Confederate vessel was hidden by thick woods, excepting from a point opposite the fort and within easy range of its guns. Here Worden dropped his anchor and attacked the *Nashville*, while the fort opened fire upon him. A few minutes after the commencement of the action, an 8-inch shot struck the pilot-house within a few inches of the Commander's head; yet no notice was taken of the fire from the fort. At the fifth discharge the *Montauk* put a 15-inch shell into the body of the enemy's vessel, the terrible explosion being distinctly heard within the turret. Several other shells also hit the desired mark, but the first had done the work effectually, and shortly the smoke and flames which enveloped the *Nashville* was the intelligence for the *Montauk's* gunners to cease firing. By unseen means, as usual, the anchor was then raised under the blast from McAllister, and Worden retired in triumph after having destroyed the enemy's vessel under his own fort; thus demonstrating that fortifications offer no protection to wooden vessels against monitors with their impregnable turrets and their nearly submerged, impenetrable hulls. The achievement marks an epoch in naval history.

"In Admiral Porter's attack on Fort Fisher, during each engagement (December 24, 1864, and January 15, 1865) the moni-

tors were stationed in a direct line between the wooden fleet and the fort. The monitor guns, it was evident, were not numerous enough to make a serious impression on the extensive lines of Fort Fisher, and yet their fifteen-inch shot and shells were indispensable to destroy bomb-proofs and magazines, etc. The sagacity of Porter proved equal to the emergency. He found, by his computations of distance and elevation, that the guns of his ships would send their projectiles just high enough to pass over the monitors, if placed about half-way between the fort and the fleet. The turret-vessels were accordingly assigned this dangerous position—dangerous to vessels less shot- and bomb-proof than monitors—as shot from the fleet falling short and shells prematurely exploding could not be avoided another a spirited and prolonged action. Here was presented during important novelty in naval tactics resulting from the introduction of the new system."

These extracts from one of Ericsson's printed letters give proof not only of the qualities of the monitors, but of Ericsson's ability as a writer. Who could have better described these episodes of war in so brief a compass?

On January 31, 1863, two Confederate iron-clad rams, *Chicora* and *Palmetto State*, so disabled and dispersed the vessels of the squadron off Charleston that a proclamation was formally issued by the Confederate authorities declaring that the blockade was raised. Within a month the squadron was strengthened by the addition of four monitors, but Admiral Du Pont, who commanded, had no faith in these new vessels and wrote (June 3, 1863) to the Department, announcing that he could not depend upon them for protection against the sea-going iron-clads fitting out in Southern ports.

The Confederates evidently shared this opinion, for a fortnight later they sent out from Charleston their iron-clad *Atlanta*, accompanied by two excursion steamers filled with intended spectators of Yankee discomfiture. She found the monitor *Weehawken*, in command of sturdy John Rodgers, ready for her, and within fifteen minutes from the time that vessel opened fire the *Atlanta* had surrendered. Yet this Confederate vessel was the one that Du Pont chiefly dreaded, and he described her as the best that the enemy had.

Still unconvinced by this brilliant stroke, Admiral Du Pont reported that the monitors could not keep the sea, nor could they in his opinion blockade Charleston nearer than the harbor of North Edisto, twenty-five miles distant. This want of faith in the vessels under his control discouraged the Government, and Admiral Du Pont was relieved from duty, greatly to his mortification and the dissatisfaction of his friends. He was succeeded in command by Admiral Dahlgren on July 3, 1863, and on the 10th of that month the monitors returned to the blockade of Charleston, where they remained until the war closed on that coast, in the middle of February, 1865.

During this service under the fire of the Charleston batteries, the *Patapsco* was in twenty-eight engagements without suffering serious injury or the slightest derangement to her turret. The *Montauk* was struck two hundred and fourteen times, and the *Weehawken* one hundred and eighty-seven times by heavy shot.

In the attack at Mobile Bay it was left for the monitor *Manhattan* to give the finishing stroke, with its fifteen-inch gun, to the Confederate iron-clad ram *Tennessee*, after Farragut had engaged her at the closest quarters with all of his wooden vessels, and three of them had rammed her with more injury to themselves than to their adversary. The *Tennessee* is described as "the most formidable vessel of her class that ever carried the Confederate flag," and it was a "subject of wonder and admiration that Southern builders and seamen, crippled in every department of construction and outfit, could have wrought their little available material to so good a purpose." Yet she was helpless under the guns of a monitor. Describing the effect of their attack on the *Manhattan*, an officer of the *Tennessee*, Lieutenant Wharton, says:

A hideous-looking monster came creeping up on our port side, whose slowly revolving turret revealed the cavernous depths of a mammoth gun.

"Stand clear of the port side!" I shouted.

A moment after a thunderous report shook us all, while a blast of dense, sulphurous smoke covered our port-holes, and four hundred and forty pounds of iron, impelled by sixty pounds of powder, admitted daylight through our side, where before it struck us there had been over

two feet of solid wood covered with five inches of solid iron. The *Tennessee* could drive shot after shot, and shell after shell, through the sides of the wooden ships, but the solid projectiles from her eight-inch rifles were impotent against the iron-clads, whose gunners, from their place of safety and advantage in the shot-proof turrets, could aim and fire with all the coolness and security of participants in an artillery target match.*

Some of the monitors during the war were hit more than five hundred times. At Fort Fisher they laid three days under fire, and from the first monitor fight to the last but three persons were killed on board of them, Captain G. W. Rodgers and Paymaster Woodbury in the *Catskill*, and one man on the *Nahant*. The death of the first two resulted from a shot striking the top of the pilot-house, and with reference to it Ericsson wrote to the Secretary of the Navy (August 29, 1863): "The injudicious objections raised by many experienced officers and engineers to the projection of the turrets above their roofs, I regret to say influenced me, or I would never have placed the top of the pilot-house flush with the shell. The deplorable accident on board of the *Catskill* imperatively calls for an amendment and resort to the orginal idea of putting the top some distance below the shell."

How many naval constructors are there who would feel called upon to apologize because two men had been killed upon one of their vessels subjected to a heavy bombardment from forts? The first shot from the fifteen-inch gun of the monitor *Weehawken* prostrated forty men on the *Atlanta*, and the third shot carried off the roof of her pilot-house altogether, wounding the two pilots, and stunning the men at the wheel. As Captain Rodgers, who commanded the *Weehawken*, remarked concerning his adversaries: "The first shot took away their disposition to fight, and the third their ability to get away." In the attack on Algiers by Lord Exmouth, in 1816, one vessel, *Impregnable* only in name, had 150 killed and wounded, and the total loss of the fleet was 141 killed and 741 wounded. At Navarino, in 1827, out of a fleet of 81 vessels only 1 frigate and 15 small vessels were in a state ever again to put to sea. The Allies lost 177 killed, 480 wounded, and

* Scharf's Confederate States Navy, p. 568.

the Turks lost 6,000 killed. At Sinope in 1853, the Turkish fleet was blotted out of existence and the Russian vessels were seriously crippled.

The *Atlanta* was the first vessel of war to hoist the flag adopted by the Confederate States, and the intention was to christen it and signalize the anniversary of the battle of Bunker Hill, on which the engagement was fought, by a glorious victory. The victory was a signal one, but not after the expectation of the good people of Savannah, who had crowded the wharves to bid the *Atlanta* God-speed when she left their port.

Wherever Confederate vessels appeared they fell a prey to the enemy—the *Merrimac* to the *Monitor*, the *Atlanta* to the *Weehawken*, the *Tennessee* to Rear-Admiral Farragut's fleet. The *Louisiana* and *Mississippi* with six or seven semi-iron-clads, disappeared from the list when Farragut captured New Orleans; one was destroyed on the Yazoo, and two on the Red River, to prevent capture by Admiral Porter. The *Arkansas* was destroyed by the *Essex*, several half-iron-clads by the flotilla of Acting Rear-Admiral Davis at Memphis. The *Chattahoochie* was blown up on the Appalachicola River and the *Albemarle* was sunk by Lieutenant Cushing with a spar topedo. All of these vessels were on the same general plan and of the type to which the *Monitor* was opposed. If they had been of the monitor type there would unquestionably have been a different story to tell.

The *Galena*, one of the two iron-clads submitted in competition with the *Monitor*, and accepted by the Government at the same time, was pierced through and through by ordinary shot, driving fragments of the iron armor within the vessel, dealing "death and damnation round." The other, the *Keokuk*, was speedily penetrated and sunk by the enemy's fire. In the attack upon Charleston, April 7, 1863, as her commander, A. C. Rhind, U.S.N., reported, she was under fire thirty minutes and was struck ninety times, nineteen shots pierced her through, at, and below the water-line. Her turrets were pierced in many places. She was, in short, completely riddled and sank the next morning when the sea grew a little rough.

"Navy officers in our service," wrote Mr. Fox in 1869, "and the English will advocate a broadside system—such was the

English report—or at least connecting the turrets by casemates, and such would have been a report of our own had we put the monitor system into their hands. It arises from education in broadside ships and the instinctive appreciation that their own position will be shaken if fighting ships are reduced to machines, the product of engineering skill. Porter is desirous of having the satisfaction of building up a navy founded upon his own ideas and English precedents. He will not follow in the wake of those who preceded him, but throwing all experience overboard, even his own indorsements, he assigns to the *Monitor shore* duty and tonnage of *eight hundred tons* and to his invulnerable sea steamer only three thousand three hundred tons. He will learn that invulnerability cannot be reached in the latter tonnage by any other type than the monitor. England, through her last ships, draws toward the monitor precedent, a fighting machine without masts and low freeboards, while we propose to take up with the earlier cast-off British broadside types. To what end will unstinted vanity lead us while the near past with its rich lessons is so fresh in our minds. I look to see a *mathematical* demonstration of the unsoundness of the proposed navy. In a monarchy, a navy is part of the show that imposes upon the people. In a republic, it should be tolerated solely for its *fighting powers*, and to that end science and genius should bend their efforts. Beyond that it is useless. We are about to swing off into a sea of expenditures for flag-ships and other pleasant homes, forgetting the type that came to us in the darkest hour of our history like Minerva fully armed from the brain of Jupiter."

"Sailors, you know," said Mr. Fox in another letter, "are conservative and impatient, slow to change old ideas and restless under efforts necessary to reach perfection, but when the hour of trial comes they will not disappoint the just expectations of the country."

Harvey said that he could make no converts to his theory of the circulation of the blood among men past middle life, and a distinguished Harvard professor, of great scientific attainments, reported to Ericsson in 1863 that he encountered at Washington "the most unaccountable absence of practical trust in great physical principles which had not been ingrained by the established modes of old naval warfare."

"In order to please the several officers of the gun-boats," said Captain Ericsson, "I have invented and applied various contrivances, but in no instance have I succeeded in calling forth expressions of approbation. Nothing I have contrived has so far given satisfaction to the commanding officers. Such herculean labor as I have performed in relation to the monitor fleet is not on record in the history of engineering."

Criticisms and complaints he had in abundance. Some of these pointed out deficiencies, to the correction of which his exhaustless ingenuity was successfully applied; some were the result of the propensity to grumble, chronic in the navy; others were the offspring of ignorant comparison between the monitors and vessels wholly unlike them in type, and some can only be explained on the theory of a deliberate determination to get rid altogether of the monitors and their creator.

After the failure of his attack upon Fort Sumter, Admiral Du Pont, as Ericsson explained in a letter to John Bourne, March 9, 1866, "to sustain his reputation induced certain monitor captains to write long reports of imaginary defects of the monitor system; for which he was dismissed from active service and prevented from further participation in the war." "Du Pont neither understands nor appreciates the monitors which have performed so marvellously," wrote Fox (February 27, 1864). "He is of a wooden age, eminent in that, but in an engineering age behind the time. You were always opposed to attacking forts, but Du Pont despised the vessels and the brain that conceived them."

Du Pont was the grandson of the Du Pont de Nemours who, on behalf of France, negotiated the treaty of 1783, by which England formally recognized the independence of the United States, and who was instrumental also in promoting the later treaty that added the immense Louisiana territory to our possessions. De Nemours was a royalist whose neck was barely saved from the guillotine by the death of Robespierre. His grandson, born in the same year with Ericsson, was a legitimate inheritor of the spirit actuating the Frenchmen in the days when "*Aprés vous, messieurs!*" was supposed to be the polite formula preceding the commencement of a battle. There was no more accomplished officer in our naval service than Admiral

Du Pont, no man of nobler personality, but he was the very incarnation of naval exclusiveness and prejudice against innovation, and the introduction of monitors into our navy gave a shock to his sensibilities from which they never recovered. It may be that he was expected to accomplish with them more than was possible in his attack upon Charleston, but he was disposed to exaggerate their deficiencies and to criticise them in a spirit of unfriendliness that arrayed against him the active hostility of their champions.

After the first attack of the naval forces under Admiral Du Pont upon the Confederate batteries defending the harbor of Charleston, S. C., a most elaborate report upon the defects of the monitors was prepared by the Admiral. In spite of this, the chief engineer of the monitor fleet reported that they were ready for action at nine o'clock upon the morning following their experience of an exposure for nearly an hour to the concentrated fire of more than one hundred heavy guns, some of the vessels being struck more than fifty times. Most of the deficiencies pointed out by the five captains whose reports were transmitted by Du Pont were such as a man of Ericsson's ingenuity could devise means to correct; the others he answered with argument and sarcasm. To the complaint of want of ventilation he replied that the introduction of a cold-air pipe could soon correct this, adding "the writer's experience in drilling men in gymnastic exercises in cramped quarters justifies him in asserting that with ample ventilation and proper treatment, the berth-deck of a monitor may be rendered the nursery of strong and healthy men."

In support of this statement the Surgeon-General of the Navy, in his annual report of 1864, stated that an examination of the sick reports, covering a period of over thirty months, showed that, so far from being unhealthy, there was less sickness on board the monitor vessels than on the same number of wooden ships with an equal number of men, and in similarly exposed positions. From the facts contained in the report, the Secretary of the Navy drew the conclusion that "no wooden vessels in any squadron throughout the world could show an equal immunity from disease."

There is something oppressive to the imagination, unques-

tionably, in an under-water residence, but it is not necessarily more unhealthy than on the exposed deck of an ordinary sea-going vessel. In the larger monitors, too, a promenade was provided on top of the turret, one hundred feet in circumference, and a hurricane deck, affording room for exercise and recreation. The first monitor was unquestionably a most undesirable place for permanent residence; in the smaller *Passaic* class, where some improvement was made, and of the *Dictator* there was no complaint. It would certainly compare most favorably with modern iron-clads, where insufficient ventilation is a great cause of complaint, and the utmost effort is required to keep the stokers up to their work in a fire-room having a temperature of 168°.

Lack of sea-going qualities was another of the criticisms of the five monitor captains. As Captain (afterward Admiral) Rodgers was one of these critics, Ericsson said in reply: "Captain John Rodgers not long ago expressed the opinion of the monitors as follows: 'During the heaviest of the gale I stood upon the turret and admired the behavior of the vessel. She rose and fell to the waves, and I concluded then that the monitor form had great sea-going qualities. If leaks were prevented no hurricane could injure her.' Such was the opinion of the cool, intrepid sailor at a moment when, tossed on the turbulent sea, he had all the *facts before him*. Why his opinion should be changed by his experience on the placid waters of the Edisto I will not inquire."

In the report concerning the behavior of the *Weehawken* in a gale, from which Ericsson quoted, John Rodgers stated that he had cut loose from the vessel towing him to save her, and that the performance of the monitor in a sea "was admirable." The sea "was about thirty feet high," he said, but "the behavior of the vessel was easy, buoyant, and indicative of thorough safety. Her movements filled me with admiration. I saw in them everything to admire, nothing to improve. The waves rolled furiously across the deck. Instead of spending their force against the side, as in an ordinary vessel, they swept harmlessly by. A plate of flat iron two inches thick and weighing some three thousand three hundred pounds was broken from its lashings upon the deck, and transported about

forty feet to some side stanchions, which arrested its course overboard, and to which it was secured."

Could testimony be more complete than this? Does it not prove all that Ericsson claimed as to the peculiar seaworthiness of the monitors, so long as the openings into the hull were kept closed, as he intended they should be? Speaking of the terrible gale in which the brave Rodgers refused to make a harbor with his monitor, Mr. Fox said: "I frankly confess that I did not believe an iron-clad could live through it. Thanks to Rodgers, the country breathes freer and you are sustained. I have nothing to add to the pleasure that must fill your heart."

Ericsson estimated that the *Dictator* could carry five hundred tons of water, or other additional weight to that amount, before she would sink. As less than two hundred tons of water, entering the ordinary screw steamers, of the size of the *Dictator*, would flood the furnaces and, by putting out the fires, cause fatal disaster, he argued that the supposed great risk of the monitors is in reality shared by all sea-going steamers. Again, the safety of an ocean steamer might be seriously endangered by shipping heavy seas, as their deck arrangements are ill prepared to encounter the risk; the monitor deck, on the contrary, is designed to be washed by the waves, and is tight and strong as the vessel's bottom.

"The monitors have not only proved sea boats," wrote Ericsson (letter to Bourne, November 3, 1863), "but they are life-boats on a large scale which cannot perish in any hurricane or raging sea, provided there is water under their bottoms and their deck openings are properly closed. The sinking of the original *Monitor* was caused by an inexperienced commander raising her turret before going to sea, and then putting oakum under its base. The turret on being let down rested on a few thick lumps, the sea washing out the rest and producing a leak of some fifty feet in extent, admitting more water than the pumps could take away. But the vessel did not go down in an instant, as reported, for it took full four hours before the stream of water under the turret overpowered the pumps. The monitor *Weehawken* went down at anchor in Charleston harbor during a gale, the forward deck-hatch having been left open

and remaining so for fifteen minutes, while the sea made a clean breach over the vessel." "We have now positive evidence," he said, "in a letter written January 14, 1865, that both seams and rivets of that vessel remained as sound as in the *Passaic*."

"Ordinary vessels," he said again, "roll because the wave on the weather side, impeded by the hull, rises to a greater altitude than on the opposite side. In the case of the *Monitor* the wave can only rise sixteen inches, after which it mounts the deck, and by force of gravity bears down the hull and checks the tendency to roll. The projecting side armor, from obvious reasons, also assists powerfully in preventing rolling. The pitching, from the same cause, is less in the monitors than in other vessels."

"As to ventilation," said Ericsson, "old sailors who have been in these vessels night and day for two years have assured me that no other vessels of war can compare with them. It must be so, since the air before entering the boiler-room sweeps through the quarters. To assume that the means of ventilation fail, is to assert that the vessels have ceased to move, there being no sails and no air for the boiler furnaces excepting what is drawn in by centrifugal blowers through the turret, or through impregnable air-trunks on deck. Ladies who have made short passages in the large class of sea-going monitors have observed that the air, unlike that of any other class of vessels, is perfectly pure, without the slightest odor such as the best passenger ships are never free from.

"Excepting when the vessel is prepared for action, hatches over the berth-deck are covered with brass plates perforated with several hundred holes in which glass globes are inserted, throwing a strong light. The officers and men therefore can read and write with facility during the daytime. . . . Those who have been present during the dancing and music on the *Dictator's* berth-deck at sea, and witnessed the comfort and delight of the men, cannot read without indignation the falsehoods propagated by the London *Times* respecting the monitor iron-clads.

"I will not detain you by a lengthened argument showing why houses could not be erected on the decks of the monitors. They are made only to fight, and their guns must sweep the

entire horizon. The *Passaic*, for instance, engaged the enemy's batteries twenty-eight times, and after each contest had to run into open water, frequently during bitter cold weather and heavy sea. What would become of the crew, had their quarters on such occasions been knocked away? To prevent blockade running at Charleston, a monitor had in turn to do picket duty every night at a point that was within easy range of *five* forts! Houses on deck would not long have been left standing by our enemy, while, owing to the impregnable nature of the turrets and the narrow line of the almost submerged hulls, the Confederates deemed it waste of powder and shot to fire. Again, a house built on deck flush with the sides, would produce heavy rolling, as the rising sea on the weather side would tilt the hull. With a clear and almost submerged deck, the effect of the rising sea is to overflow it, and thus bear down and steady the hull. Bottles and inkstands on board of the monitors are left without support in all weathers."

Ericsson was especially severe upon Captain Percival Drayton, who, as he said in a letter to Secretary Welles, "seemed bent on prejudicing everybody against the vessel under his command. I will try to believe," he added, "that it is *mechanical* difficulties alone that appall him." Captain Drayton had punctured Ericsson in a tender spot by declaring that he was guilty of an error "in calculation" in the trim of the *Passaic*. In reference to this Ericsson said: "I used all my influence to have it corrected. Mr. Stimers, in reply to my earnest representations on the subject, told me that Captain Drayton preferred it and liked to have the bow high out of water. Much useless weight was put into the *Passaic*, against my remonstrance, to please the commander. Unfortunately, the various useless fixtures have been copied into the rest of the vessels."

Captain Drayton had reported that the monitors were liable to spring a leak because of their peculiar construction. To this Ericsson replied:

Captain Drayton's several reports show how necessary it is to receive with caution the statements made and inferences drawn, even by experienced and impartial seamen, in relation to our new system. Captain Drayton reported to you January 1st, that "the sea was gradually making large openings through the forward armor projection, through

which the water poured in a large stream." He added confidently "that a few hours of heavy sea would go far to tear the whole thing off." Without having during the interval lifted a hammer or driven a rivet, the same officer reported, January 22d, that although during two days and one night, "it blew so very hard that the *Passaic* could not make the light-vessel," yet "there was no difficulty in keeping her free with the bilge-pump (only five inches in diameter) and *one* donkey-pump working two hours out of every four. Comment on the discrepancy of Captain Drayton's reports of January 1st and 22d is unnecessary. It is important, however, to notice the reported expedient of removing the ballast which he says "had most inconsiderately been placed inside of the false bow." Captain Drayton means the ballast placed on the forward overhang. In a former report Captain Drayton described the fearful action of the sea *under* this overhang, which tended to "tear it up." The weight which I have directed to be stowed in the overhang to counteract this upward force and prevent the projecting bow from being lifted up, the report of January 22d informs you, was as a necessary measure of "precaution" removed. . . .

Without intending any disrespect to the commander of the *Passaic*, I cannot abstain from calling your attention to his singular custom of drawing on the imagination in order to show what *might* have happened under certain contingencies, and what dire consequences would have resulted from occurrences which happily did not take place.

The result of the observations made by Captains Rodgers and Worden are stated with much precision, but the opinion expressed by these officers, that their vessels were subjected to severe strain, is unsupported by practical evidence. So far, not a rivet has started nor a seam opened. No working has been observed at any point within the vessel. The absence of buoyancy in a heavy sea, supposed by Captain Worden to be a defect, is in reality a favorable feature. It is in heavy weather that ordinary ships suffer most from the excessive and violent movements caused by the sudden rise and fall with the sea. Under similar circumstances the monitor craft becomes partially immersed by the waves which *pass over its decks*, instead of violently tossing it up and down during their oscillation. Without disparaging the judgment of the two commanders last alluded to, I would suggest that their impressions regarding great strain on the vessel has been produced by the strong sound which accompanies the lashing of the sea against an iron hull. An observer accustomed only to the light, dull sound of a wooden vessel is startled by the sharp, harsh ring of the metallic hull, and imagines serious strain where in fact nothing but a very natural and harmless sound occurs. . . .

A still more conclusive answer to these criticisms followed an examination of the *Passaic*, after she had been put on the marine railway at Hunter's Point. Not a single rivet had been

started, nor a single joint opened at any point where the side-armor shelf or end projections join the hull. All was found firm and solid. "It seldom happens," wrote Ericsson triumphantly to Secretary Welles, "that erroneous statements, promulgated officially, receive such positive contradiction as the actual state of the *Passaic* gives to Captain Drayton's report. The perfect state of the *Passaic's* hull furnishes the best evidence in support of my theory that, owing to their almost entire submersion, the strain on monitor vessels, even during a gale, is quite moderate. Nautical science teaches that submerged bodies are but little affected by the violence of the waves. The frail raft drifts unharmed with the sea, while the top-hamper, the iron-bound masts of a first-class ship are torn to splinters. The nautical student knows that the actual progress, the onward movement of the sea during a gale, is but moderate, and he knows also that at a small depth below the surface the water is stationary, and that still lower down its motion is retrograde to the direction of the wind."

Other officers who could not conquer their preference for "wooden vessels and shell guns" received some elementary instruction from Ericsson on the requirements of their profession. This they naturally did not relish. Some of them were informed that their elaborate criticisms of a vessel they did not understand did not convey "a single new idea, nor develop a single new fact," which, however true, was at least not palatable. So there was a strong professional sentiment united in opposition to this "Daniel come to judgment." One of the fears expressed was that the pilot-house would be upset by the impact of a shot. This was answered in a letter showing the relation between the inertia to be overcome, and the blow of a projectile which, on striking, would have its momentum stopped in the 6000th part of a second.

The management of some of the engineers upon whose skill the reputation of his monitors in a measure depended, was even more disturbing to Ericsson's equanimity, and he recorded a most vigorous protest in a private letter to his friend Fox (December 3, 1862), saying:

I earnestly beg of you to instruct the Chief Engineer of the Navy to send us men fit to run the engines of the iron-clads, or the country will

soon witness disaster little anticipated. To intrust the national vessels to such shockingly ignorant and incapable young men as the so-called engineers of the *Passaic* is criminal. You must not feel offended at my remarks, the occasion demands candor on my part. The poor young men exhibited such lamentable ignorance during the construction of the engines as to excite the contempt of our workmen. Two of our foremen formally called upon me with a respectful remonstrance against the engines and boilers being put under the care of these young men, asserting in the most positive terms that they would "blow up the boilers before getting to Hampton Roads." I will merely add that, but for the enormous strength of the decks of the iron-clads to resist the upward pressure of the tops of the boilers, there would be no *Passaic* now, and no one to tell how it happened.

The engineer of the *Montauk* was no better. "It would hardly seem credible, yet the engineer has been observed to blow off the boilers under a pressure of thirty pounds, and at once permit cold water from the sea to return, in order, it would appear, to cool the boiler quickly. Again, he has been observed to turn steam of full pressure from one boiler in operation into the other not in operation, but filled with cold water. In either case the resulting unequal temperature of top and bottom of boiler is sufficient to strain the joints and crack the plates, and cause utter destruction to the boiler."

Of the Chief of the Bureau of Steam Engineering at this time, Ericsson wrote to Bourne (May 15, 1866): "This person, who is utterly devoid of constructive skill, not an engineer from the start; smart as a writer and compiler, and an unmitigated . . . is and has been my persecutor for twenty years. But I am happy to say he has not been able to hurt me, and that notwithstanding his high position he has not been able to prevent my constructing the engines of the entire monitor fleet now afloat, excepting the *Miantonomoh* and *Tonawanda*, into which he was ordered to put engines to compete with the *Monadnock* class. He was beaten, although, contrary to instructions, he put in twenty per cent. more power than I had applied. Having first, let me observe, caused me to be restricted to smaller engines than I had proposed."

In the case of the *Monadnock*, referred to here, Ericsson being ordered to construct an engine in competition with the Bureau engines, anxious for the best result, offered to increase its size

at his own expense. He was refused permission, on the plea that his cylinders could not be made larger than those of the Bureau engines, which, as he charged, were secretly enlarged. Now that engines are using triple and even quadruple expansion, it is well to remember that the Bureau chief, contrary to the advanced practice even at that time, insisted, upon the strength of a misleading experiment, in declining to use expansion. "Wilfully shutting his eyes to the work of improvement going on daily in England and France," as a leading English authority declared (London *Mechanical Magazine*, January, 1864), "and with a temerity almost without a parallel, staking the future of a great navy and an enormous sum of money on the truthfulness of a simple obscure experiment, bearing but a remote analogy in its conditions to those under which steam should properly be employed. It is as though the American engineering world had retrograded the third part of a century."

"The idea of denying the value of expansion," said another authority, the London *Engineer*, "in the face of proved facts innumerable, is transcendently ridiculous. The fact that such a belief should be supported by a great naval power is almost incredible."

Incredible as it seemed then, and still more incredible as it appears now, it was true, and Ericsson was compelled to submit his engineering conceptions to the criticism of a man so perversely misleading the authorities of the Navy Department, in so important a matter as the motive power of the vessels upon whose efficiency everything depended.

Fortunately for him, he was not obliged to approach the heads of the Navy Department through their bureau chiefs. He had their full confidence, and was always admitted to direct access, and his thorough mastery of the subjects he discussed, his clear and forcible way of presenting his views, were very convincing. He was a master of expression, and there is not a line in all of his numerous letters on professional subjects that could not be readily understood by anyone who has learned the four primary rules of arithmetic. He had a contempt for displays of learning which depended upon obscurity of statement, and the unnecessary exhibition of mathematical formulas, though few

had a more complete knowledge of them than he. His own conceptions were so exact that he had no difficulty in conveying them to others, whether they were accepted or not; and having a thorough control of English expression, his thought flowed as clearly as a limpid mountain stream, even when he discussed technical questions.

The necessity which arose during the war for keeping vessels in motion while taking soundings, to lessen their exposure to the fire of hostile batteries, directed attention to the sounding instrument Ericsson and Ogden had invented in 1838. It was claimed for this that it would take soundings "irrespective of the length of the lead line;" meaning, of course, that the record was made upon the lead itself, and not by calculating the amount of line paid out. A naval officer, to whom the instrument was entrusted for experiment, seems to have interpreted the statement more literally, and reported that it was useless because it would not register with a line so short that the lead was merely towed behind the vessel without reaching bottom. When this was reported to him, Ericsson responded with a vigorous letter, declaring that "the illiberal manner in which the trial had been conducted would place the name of the present commander of the *Passaic* side by side with those who denounced the loom, the steamer, the railroad, and the telegraph." This was treatment usually awaiting new devices. One who can neither build nor manage a locomotive can easily throw it off the track, and men who are incapable of originating anything else often have a great capacity for originating doubts.

CHAPTER XXIII.

FOREIGN RECOGNITION.

Foreign Demand for Monitors.—The *Miantonomoh* Crosses the Atlantic. —Her Behavior at Sea.—Correspondence with the British Admiralty.—England's Fleets again Made Obsolete by Ericsson.—Ruskin's Opinion of Ships of the Line.—England's Mistaken Policy toward the United States.

AS soon as the news of the success of the *Monitor* had gone abroad, applications came to Ericsson for his assistance in building similar vessels for foreign powers. The month following the battle in Hampton Roads, a New York business house asked terms for one or more monitors, "to be delivered in the Mediterranean." Another concern proposed to pay $10,000 for the plans of each vessel they might contract to build for "any European power." The Secretary of State, Mr. Seward, asked that the Danish Minister be provided with drawings and specifications for two monitors, and these were furnished, with an offer to build the vessels for $400,000 each, the price charged for the *Passaic* class, of which they were to be copies. But the Secretary of the Navy not unreasonably objected, "for the reason that other governments had demanded similar concessions, with which it was not considered convenient to comply." So the specifications were not sent to Copenhagen.

On June 23, 1862, Ericsson offered to construct for the Chilian Government a monitor precisely like the five he was then building for the United States, and for the same price, viz., $400,000 in United States currency. The vessel was to be ready in six months, and to make nine knots speed. A similar offer was made to the Peruvian Government, with an increase of price to $450,000, the Government having meantime imposed a tax of three per cent. on all contracts. It was stipu-

lated that the monitors should be built and then taken to pieces for transportation in sailing vessels, and this was inadmissible. The requirement was at first acceded to, and then, "on mature reflection," the order was declined.

The Swedes and Norwegians also wanted monitors, but it was not until 1866 that the Swedes were able to test the first of the fleet of vessels built after Ericsson's plans. On this the name of *John Ericsson* was bestowed by King Charles XV., and she was armed with two fifteen-inch American guns, presented to Sweden by her absent son, at a cost to him of $14,200, guns of the same calibre being cast in Sweden for the rest of the fleet. The first appearance of this aggressive nondescript at Stockholm "delighted the patriotic Scandinavians almost to frenzy, as affording effective means of keeping away hostile war ships carrying Russian intruders."

The first Norwegian and three Swedish monitors went upon a cruise together. Upon their return an officer of the Norwegian navy wrote to Ericsson, September 17, 1867, saying:

> I feel it a pleasant duty to inform you, that this great invention of yours has here also fought its way up to that position of acknowledged pre-eminence which can be attained only by inventions based on true principles. You have thus the satisfaction, denied to many great men, of being justly appreciated by the world while you are yet in full vigor of life. Honor to him who has placed in the hands of the smaller states a weapon with which they can successfully defend themselves against the aggression of stronger nations!

It was not the smaller states alone that were to enjoy the results of Ericsson's labors. Plans of the monitors were furnished to Russia from Washington, and ten monitors were included in the iron-clad fleet created in 1862–64 by Admiral Crabbe, under the auspices of the Grand Duke Constantine. These were built from copies of the drawings prepared for the American monitors. With them the Grand Duke Constantine paid a visit to the King of Sweden, to show him that Ericsson's ideas had not affected the relative status of nations.

In April, 1866, universal attention was directed to Russia by an attempt made upon the life of the Czar, Alexander II., by one of the Nihilist conspirators. Remembering the cordial

good-will shown to the United States by Russia during the period of national trial, when public sentiment was most sensitive to sympathy or criticism, it was resolved that something more was due to this friendly power than a mere perfunctory expression of satisfaction at the failure of the conspiracy against her peace. Congress passed a joint resolution expressing the regret at the attempt made on the life of the Russian ruler, and to give added significance to this token of good-will, it was resolved to send the resolutions to Russia by a special envoy in a national vessel.

For this mission Congress selected Ericsson's friend, the Assistant Secretary of the Navy, Gustavus Vasa Fox. Mr. Fox determined to avail himself of this occasion to test the qualities of the monitors, as he had still the most unlimited faith in these "marvellous vessels," as he was accustomed to call them. With reference to his proposed visit, Mr. Fox wrote to Ericsson (April 23, 1866), saying:

The country never can and never will do you justice pecuniarily for the inventions which have been so useful, and which have realized the creations of imagination, and which are the results of genius in comparison with other systems which are born of labor and art and long study. Your reward cannot be counted in gold and silver, or income; it is immortality and your own happiness at success. Nevertheless, you will, I trust most sincerely, have all you desire here in this life. I think I have rendered the state some service in the last five years, with great opposition to encounter and radical changes to make while a great war was in progress. I commanded the operations of the navy as much as Halleck did the army, and always with success; yet Congress reduced my pay from $4,000 to $3,500 before the war closed, and I leave next month with not money enough to get home to Portsmouth, N. H. I do not complain; I am perfectly happy, and I would not exchange the victories we have won over *all* our enemies for any wealth. What aid and assistance your brain has been to us I have publicly declared upon all occasions, and I will teach them yet, in Europe, what they fail generally to comprehend, the monitor. That done, I shall take leave of all my studies and experiences for the purpose of making money before old age comes. I shall resign before I go to Europe and go out as a Commissioner of the Government to visit dock-yards, etc., so as to cover my expenses. I need not assure you how confidently I believe that the raft principle will prevail for iron-clads, and I should like to see it tried for passenger steamers. The victory has come to you at last through the trials all must go through.

Referring to this letter some years after, Ericsson said: "My memory recalls the emotion I experienced when you informed me in a friendly note, at the close of the gigantic war in which you had rendered the Republic such signal services, that you had not money enough to take you back to your native town. We read of such disinterestedness in romance, but do not look for it in real life. How fortunate if the great Republic furnishes many such instances of patriotism and integrity!"

For the mission of Mr. Fox the monitor *Miantonomoh* was chosen. She was a Navy Yard built, two-turreted monitor, carrying four 15-inch smooth-bore muzzle-loading guns, and was commanded by Commodore J. C. Beaumont, U.S.N. Two other naval vessels, the *Augusta* and the *Ashuelot*, accompanied her as escort. A profound impression was created among the sceptics, especially in England, by the actual appearance on the other side of the Atlantic of the strange vessel they had so long persisted in declaring incapable of making a sea voyage. To the guns of the *Monitor* they had nothing to oppose in the way of defence, for the foreign guns of that day were ineffective against a vessel carrying ten inches of armor on the turret and seven inches on the sides. Not only were the monitors superior to the broadside vessels of England for fighting purposes, but also as sea boats. As the result of his experience, Mr. Fox, in the published report of his mission, said:

The facts with regard to the behavior of this vessel in a moderate gale of wind and heavy sea are as follows: Head to the sea, she takes over about four feet of solid water, which is broken as it sweeps the sea along the deck, and after reaching the turret it is too much spent to prevent firing the 15-inch gun directly ahead. Broadside to the sea, either moving along or stopped, her lee guns can always be worked without difficulty, the water which passes across the deck from windward being divided by the turrets, and her extreme roll so moderate as not to press her lee-guns near the water. Lying in the same position, the 15-inch guns can be fired directly astern without interference from water, and when stern to sea, the water which comes on board is broken up in the same manner as when going head to it. In the trough of the sea her ports will be liable to be flooded, if required to use her guns to windward. This, therefore, would be the position selected by an antagonist who designed to fight a monitor in a sea-way.

An ordinary vessel high out of water and lying in the trough of the sea, broadside to, is attacked by a wave which climbs up the side, heels

her to leeward, and, passing underneath, assists in throwing her back to windward, when another wave is met and the heavy lee lurch is repeated. A wave advancing upon a monitor in a similar position finds no side above the water to act against; it therefore climbs aboard without difficulty, heels the vessel a few degrees to windward, and passes quickly to leeward underneath. The water which has got on board, having no support to force it on, and an inclined deck to ascend, becomes broken water, a small portion going across the deck and off to leeward, but the largest part tumbling back to windward, overboard, without sending against the turret anything like the quantity which first got on deck. The turret-guns thus occupy a central position, where, notwithstanding the lowness of the vessel's hull, they are more easily and safely handled in a sea-way than guns of the same weight above the water in a broadside vessel.

The axis of the bore of the 15-inch gun of this vessel is 6½ feet above the water. The extreme lurch when lying broadside to a heavy sea and moderate gale was 7 degrees to windward, and 4 degrees to leeward, mean 5½ degrees, while the average roll at the same time of the *Augusta*—a remarkably steady ship—was 18 degrees, and the *Ashuelot* 25 degrees, both vessels being steadied by sail. A vessel which attacks a monitor in a sea-way must approach very close to have any chance of hitting such a low hull, and even then the monitor is half the time covered by three or four feet of water, protecting herself and disturbing her opponent's fire.

Lying in the trough of the sea with her engines stopped, on purpose to ascertain her behavior under the most trying circumstances, the maximum roll of the *Miantonomoh* was but seven degrees. Eighteen degrees was a common experience with broadside British iron-clads, and there have been occasions on which they actually rolled the shot out of their guns. On board one of the largest of them the guns, when loaded and cast loose, ran out with such violence, owing to the rolling of the ship, that the carriages brought up against the ship's side with a force sufficient to start the rifled shot and cause them to fall from the guns into the green seas which washed their muzzles. It was then attempted to fire the guns on the rise, but the shot went heavenward, heaven knows whither, and one gun at least was carried right off its slide by the force of the recoil, combined with the inclination of the deck. The *Bellerophon* and *Lord Clyde* in an Atlantic swell rolled through an arc of 34 degrees.*

* The London Engineer, December 21, 1866.

When the *Miantonomoh* arrived at Queenstown, Mr. Fox and his party waited upon the Admiral commanding the station to pay their respects. His residence overlooked the roads and they found him critically examining the monitor through a glass, nothing but her turrets being visible from the bluff where he stood. After exchanging salutations, the Admiral asked Mr. Fox, somewhat abruptly:

"Did you cross the Atlantic in that thing?"

On Mr. Fox replying that he did, the Admiral said, with much emphasis: "I doubt if I would."

Ericsson's friends in England had fought hard for his recognition, but until this moment it had not been accorded, for naval sentiment and prejudice, and dock-yard interests were all against him. In February, 1864, Mr. Bennett Woodcroft, of the English Patent Office, who was thoroughly familiar with Ericsson's mechanical labors, asked him to send some account of his inventions for publication. In reply he was told: "At present it is wholly out of my power to attend to so unimportant a matter as my own affairs. I have not a single moment to spare. The fact is that my inventions have multiplied so rapidly within the last fifteen years that it will be a very arduous undertaking to record the same."

Another earnest friend was John Bourne, C.E., author of the standard treatise on the steam-engine and screw propeller, and of other works dealing with mechanical inventions. Early in 1863 he wrote to Ericsson, saying: "There is a very general appreciation of your talents in this country among engineers, and a regret that through the stupidity of our Admiralty those talents were lost to this country.

"As in the case of the screw propeller, so in the case of the monitors, we will have justice in England." It was certainly well for England that she should recognize the abilities of the man who had expended less in building a fleet of a dozen formidable iron-clads than her ordnance officers had wasted in the unsuccessful effort to produce a gun sufficiently powerful to protect her against such craft.

February 28, 1865, Mr. Bourne wrote suggesting that Ericsson should offer to construct vessels on his plans for the Admiralty, and proposed to conduct negotiations to that end. "I

quite concur in the opinion," he said in other letters, "that our iron-clads are a mistake, that the construction of our navy must begin anew, and that it must be on the turret system. There has been great misstatement as to the sea-going properties of the monitors, and I think two parties have been interested in running them down; first, Coles's party, who hope thus to conceal their piracies, and second, the Admiralty people who have been against Coles, and who, to resist him, have been willing to deal a thrust at the turret system." Mr. Bourne further says: "With all its weaknesses and faults there is, in public opinion in England, a vast amount of honesty and a sincere desire to do and believe what is right and true; and where such a disposition exists it can never be very difficult to set it right on any topic engaging public attention. In technical matters the difficulty is less than in general matters, as the audience is smaller—is without prejudice—and is competent to apprehend mechanical argument. And the general public, in such matters, take their creed from those who are more instructed. The body we have to do with is *the engineers*, and once they are set right they will soon be able to set right all the rest."

Finding in January, 1866, that the Admiralty had "broken with Coles," Mr. Bourne wrote to Mr. Reed, Chief Constructor of the British Navy, suggesting that, as public opinion in England required that the turret system be fairly tested, and as Ericsson was the author of that system, it would be well to open negotiations with him. "I have the same sympathy with Mr. Reed," wrote Bourne to Ericsson, "that I have with you, for he is a man of practical ability who has been placed in an onerous position, heretofore occupied by amateurs or pretenders, and he has the full diapason cry of that class against him. He is fighting the battle of practical men against party intrigues, family interest, and other such things imported so commonly into public affairs."

With a subtle knowledge of Ericsson's chief weakness, Mr. Bourne added: "Do not let us have any fighting, which is a slow and thankless process, and creates an amount of friction that impairs or arrests the force even of great talents."

Again Mr. Bourne wrote: "Mr. Reed has a very genuine

admiration of your talents, and is without one particle of jealousy or pettiness in his nature. I know the contempt and aversion which you must naturally have for the common order of officialism. But that weed only thrives among the inferior order of minds, whereas Mr. Reed is a man of talent, who has been brought in over the heads of *hoc omne genus ;* he is naturally distasteful to them and has no sympathy with them. His sympathies are with men of talent and against officialism. The Admiralty now is quite a different place from what it was when the wiseacres there maintained that your screw boat would not steer."

Mr. Bourne was somewhat too sanguine in his conclusion concerning my Lords of the Admiralty, as the following correspondence will show:

BERKELEY VILLA, REGENT'S PARK ROAD,
LONDON, January 31, 1866.

THE SECRETARY OF THE ADMIRALTY.

MY LORD: Understanding that it is the intention of my Lord Commissioners of the Admiralty to test more fully the qualities of turret vessels in the British Navy, and concluding that their Lordships would wish to take advantage of the valuable experience acquired with such vessels in America both under fire and in heavy seas, I have the honor to state that I am authorized by Mr. Ericsson, of New York, the inventor of the turret system, to say that he will be happy to co-operate with their Lordships in the production of one or more such vessels, which co-operation might be by taking a contract for them, as in the case of the engines of the *Amphion*—the first English screw vessel with the engines below the water-line—or it might be in any other way that my Lords may consider preferable.

Mr. Ericsson has considered that it would be more agreeable to my Lords that the communication should come from someone in London with whom the officers of the Admiralty could, if necessary, confer, than that it should form the subject of correspondence with himself in New York.

I have the honor to be,
Your most obedient, humble servant,
JOHN BOURNE.

ADMIRALTY, April 13, 1866.

SIR: With reference to your letter of 31st of January, I am commanded by my Lord Commissioners of the Admiralty to acquaint you that they are not prepared to accept the proposal of Mr. Ericsson to af-

ford their Lordships the advantages of his services in regard to the construction of turret vessels.

I am, sir, your obedient servant,

W. R. ROMAINE.

JOHN BOURNE, ESQ.

LONDON, May 30, 1866.

THE SECRETARY OF THE ADMIRALTY.

SIR: I have communicated to Captain Ericsson, in New York, the reply with which you honored me on April 13th to my letter of January 31st, and in which you state that their Lordships are not prepared to accept the proposal which I was authorized by Captain Ericsson to make, that he would offer them the advantage of his services in regard to the construction of turret vessels.

In now notifying you of Captain Ericsson's acquiescence in that decision, I may be permitted to express my regret that their Lordships have not been able to render available for the public interests the talents and experience of one of the most remarkable men of the present age, and whose assent to my proposal that he should give the Admiralty the benefit of his information I thought it a matter of some importance to have obtained—especially as he was willing to have acted without emolument or conditions—both his reputation and his wealth rendering him independent of such considerations.

I have the honor to be your most obedient servant,

JOHN BOURNE.

P.S.—The monitor vessel, *Miantonomoh* is about to leave the United States for England, and may be expected in Portsmouth about June 20th with Mr. Fox, the Assistant Secretary of the American Navy, on board. J. B.

It was at Mr. Bourne's suggestion and solicitation that Ericsson had authorized him to make the proposition he did to the Admiralty. But again, "the vessel would not steer with the power applied to the stern." Perish the British Empire rather than suffer British officialism to be urged beyond its wonted pace, or forced into new channels by the propulsion coming from a foreign inventor!

The action of Mr. Bourne had placed Ericsson in a wrong light, and upon receiving copies of this correspondence he wrote (May 11, 1866), saying:

The tone of the reply you have received from the Admiralty annoys me greatly, and I request the favor of you to get me out of the false position in which I find myself. Please, therefore, inform my Lord Com-

missioners in a positive manner, that I offered my services free of charge, merely from a motive of being useful to England, without the friendly aid of which, my native country will sooner or later become a Russian province. It will do no harm if you tell their Lordships that apart from my motive being strictly patriotic, I am in a position to render, and do habitually render, professional services of such character without pay.

The *Miantonomoh* came as Bourne had promised. At Portsmouth and in the Thames she was visited by the Prince of Wales, the Duke of Edinburgh, the Lords of the Admiralty, encased in their armor of official prejudice, naval officers without number, as well as curious crowds who flocked by the thousand to see the latest Yankee wonder. The sensation she created was indescribable. Ridicule had changed to wonder, and doubt to alarm. Visitors saw, as the London *Times* declared (July 17, 1866), "a portentous spectacle, a fabric something between a ship and a diving-bell—the Romans would have called it a tortoise—almost invisible, but what there was of it ugly, at once invulnerable and irresistible, that had crossed the Atlantic safely. Round this fearful invention were moored scores of big ships, not all utter antiquities, but modern, and there was not one of them that the foreigner could not have sent to the bottom in five minutes, had his errand not been peaceful. There was not one of these big ships that could have avenged the loss of its companion, or saved itself from immediately sharing its fate. In fact, the wolf was in the fold and the whole flock was at its mercy."

The unhappy *Times* had been occupied for years in belittling the monitors; it now proceeded to consider the cost of the 735 ships of the Royal Navy suddenly become antiquated, fit only to be laid up "and painted that dirty yellow which is universally adopted to mark treachery, failure, and crime." Just as the artillery of the Normans was superseded by that of the Plantagenets, so was the Navy of England rendered obsolete by this nondescript vessel, hardly showing itself above the water, and discharging with perfect steadiness and accuracy a projectile against which even the best British armor-plate was not proof. If the Yankee vessel was invincible to the best and most modern of England's naval constructions, what hope

was there for the swarm of ancient curiosities encumbering her anchorages?

On the occasion of the *Miantonomoh's* visit, Sir E. J. Reed declared that a turret vessel could be made more secure against rams than any existing vessel; that it was only by boldness and energy equal to theirs that England could compete with the bold, energetic nation that had sent the *Miantonomoh* across the Atlantic; that he admired immeasurably the daring genius of Ericsson in sending ships of the monitor type to sea; and finally, that it was necessary to develop the leading idea of that class to secure the most formidable war vessels. No such boldness was displayed: "Frenchmen," said the *Revue des Deux Mondes*, November, 1866, "have the satisfaction of saying that England, forced in spite of herself into a path for which she has no liking, inasmuch as to adopt it is to annihilate the colossal wooden Navy of which she was so proud, is content to follow in our wake. She seems deficient in the science of artillery and of war-ship building; she spends money by millions without producing anything that gives her satisfaction; she hesitates between the monitor and the iron-clad frigate, and seems afraid to settle definitely her course of naval action."

The *Times* was oppressed by the thought of the resistance that would inevitably be aroused by any attempt to bring the British Navy up to the mark of the day. Against this *vis inertiæ* Ericsson had struggled all his life. Only once had he succeeded in overcoming it, and that was when the exigencies of war gave him control of the naval construction of a great nation, and enabled him to silence, if not to convince, naval prejudice. He had his way for a brief period, only because the affair at Hampton Roads satisfied our naval authorities, for the time being, that they could not afford any longer "to pile sailors in tall ships, where they are as devoted to destruction as the captives said to be crammed into huge figures of wicker-work by our British forefathers, and burned in honor of their gods."

"It is hardly reasonable to expect," said the London *Times*, "that anybody that has had a share in the creation of one of our magnificent three-deckers should ever consent to its destruction, or even to its disuse. The officers of her Majesty's

Naval Service are a very gallant body of men, and they are prepared to brave the foe and the fury of the elements; but they will not easily be persuaded to live below the water-line, and to be supplied with air by a steam-engine. We wait for war to convert old sailors to such a novelty as this. It is the public and not the Service that will lead the way." It is impossible to transfer to a monitor the sentiment connected with a line-of-battle ship, of which Mr. Ruskin says in his "Harbors of England:"

For one thing this century will, in after-ages, be considered to have done in a superb manner, and one thing, I think only. . . . It will always be said of us, with unabated reverence, "They built ships of the line." Take it all in all, a ship of the line is the most honorable thing that man, as a gregarious animal, has ever produced. By himself, unhelped, he can do better things than ships of the line; he can make poems and pictures, and other such concentrations of what is best in him. But as a being living in flocks, and hammering out, with alternate strokes and mutual agreement, what is necessary for him in those flocks to get or produce, the ship of the line is his first work. Into that he has put as much of his human patience, common-sense, forethought, experimental philosophy, self-control, habits of order and obedience, thoroughly wrought handwork, defiance of brute elements, careless courage, careful patriotism, and calm expectation of the judgment of God, as can well be put into a space of 300 feet long by 80 broad. And I am thankful to have lived in an age when I could see this thing so done.

Ericsson did not share the hopeful anticipations of Bourne as to Mr. Reed's open-mindedness, and the disposition in England to deal fairly with invention when once the facts were understood. Drawing upon his own rich store of practical experience, he sent a striking reply to his friend's various arguments and suggestions to this effect (May 1, 1866):

Your reasoning about the futility of attempting to smother invention is not new to me. Every point you make presented itself to my mind long ago, but what I, in 1836, fully expected to see brought out by other inventors within a year or two, has not come yet. England—ingenious, mechanical England—like a certain animal deeming himself safe providing his head is protected, spends millions after millions, adding inch after inch to the thickness of armor-plates, for the purpose of producing

towering, impregnable iron castles, placed upon, not "sand" as the fable relates, but upon a thin bladder that may be pricked in a thousand ways. Let us not do the inventors of England the injustice to say that *they* have overlooked the matter.

Some ten years ago, you will remember, the mechanical journals depicted various contrivances for sinking an enemy's ship. The Admiralty, however, remained indifferent, and will remain indifferent. Their Lordships have unintentionally done the right thing, in my opinion ; for already the introduction of iron-clads has, by throwing out of the count England's mighty fleet of ships of the line, rendered her voice only half as potent as it used to be. If now her sons set to work elaborating the subaquatic system of warfare, build and carry into practice, so that her enemies may learn—that they may be fully convinced that there is no mistake about her iron-clads too being worthless—then, what little influence Albion yet possesses will be diminished in proportion to the success of the proposed device.

I say again, leave the thing alone and let England retain what prestige she has left. In twenty years there will be a mighty change, for by that time the expense of the present armament will become insupportable, and nations will come to a better understanding. But for the appearance of the unscrupulous and dynasty-mad Napoleon III. on the world's stage, and but for the fatal course adopted by cunning, adroit Palmerston, who lacked the power of looking into the future, England would have no occasion at present to waste her energies on iron-clads and torpedoes.

Could English statesmen have seen the folly of treating America as a commercial rival, and the futility of attempting to arrest her onward course by committing the crime of helping to perpetuate slavery, England and America, the Anglo-Saxon race, would now rule the world. Once more, do not be in a hurry to do anything tending to disturb the present balance by showing that there is no such thing as *maritime* power. The truth will leak out some day, but I trust not until its promulgation will be harmless to that country to which mankind is mainly indebted for the enjoyment of liberty.

What you say of Russia compels me to observe that the unfriendly course of England has driven America into the hateful embrace of the executioner of Poland. We had no other friend during the late fearful war. Deluded by English misrepresentations, all civilized Europe was on the side of slavery. But pray do not for a moment suppose that the liberty-loving citizens of the United States have any genuine sympathy for the semi-barbarians east of the Baltic.

Respecting the Russian monitors, I say, the more the merrier. And with regard to the American torpedo boats, I reluctantly observe that our achievements, in a mechanical or scientific point of view, have been contemptible. The plans proposed and carried out remind one of catching wild birds by putting salt on their tails. To pull secretly

alongside an enemy's vessel moored to a dock, in a dark night, and putting a bag of powder under her bilge and setting fire to it, as was done by Lieutenant Cushing, proves great daring, but nothing more. . . .

Written a quarter of a century ago, this letter is the clearest possible statement of the conditions and tendencies of naval construction, as they have since revealed themselves, and as they were present to Ericsson's prophetic vision even many years earlier than this, when his ideas of monitor construction and subaquatic attack had begun to take definite shape. The end he had constantly in view was to make the ocean such an uncomfortable place for the maritime bully, that a consensus of opinion would finally compel its recognition as neutral territory. Just as the invention of fire-arms has put the weakest saint upon an equality in physical contentions with the bullies of the prize-ring, so the possibilities of subaquatic attack have placed the weakest of maritime nations upon a par with the strongest.

If, as Ericsson believed, it is in the power of science, by the expenditure of thousands, to neutralize the vessels upon which wealthy nations have expended their millions, and with the labor of half a dozen men to counteract the less skilled efforts of as many hundreds, of what profit is naval warfare? Devoting to the study of mechanical science the resources of a mind especially created for such investigations, Ericsson comprehended, as few men do, the enormous changes in the relations of men and of nations that must follow from the inventions and discoveries of the present century. No wit is true, as never before, that "the stars in their courses fight against Sisera." The powers of nature are arraying themselves against those who would establish empire by any other than peaceful means.

Wars will not cease until human nature is changed, but they will be more and more confined to those mighty movements which, in the order of Providence, seem to be essential at times to national regeneration. The issues will be between peoples and not between states, and in their origin and results future contests will be national and not dynastic. To this end no man has contributed more in his day than John Ericsson.

It is obvious that it was Ericsson's purpose to drive fighting

men from the ocean; not to make them comfortable there; and there was an inevitable antagonism between his point of view and that of the naval officer. For the mere dignities of the quarter-deck he had small respect, and he dealt with admirals and commodores as only so many parts of his fighting machine. He sought to elevate engineering science above nautical experience, and to give to "greasy mechanics" the place of honor to which he believed them entitled in this age of steam and iron. He simply fought out on new lines a contest dating from the beginning of modern naval experience. Warlike training requires that the fighting instinct should have the position of control, and this tends to place those who minister to the mechanical forces, of which even warriors must avail themselves, in the position of the galley-slaves, chained to the oars, who contributed to the glory of the warriors of old without being suffered to share it. England's early naval heroes were soldiers and not sailors, and they were wholly dependent upon the nautical skill of their sailing-masters for their ability to fight upon the ocean, instead of upon the land. Finally, the character of the modern naval officer developed out of a substitution of what may be called a chemical union of the soldier and the sailor for mere mechanical association. Scarcely had this result been accomplished when the substitution of steam as a motive power resolved into their original elements these motive and militant forces.

Once more the attempt to unite them is in progress, and its success is for the future to determine. Ericsson's career belongs to their period of antagonism, and this in a measure explains the difficulties with which he contended through life; from the day when he prophesied to his friend Count von Rosen, in Southampton Harbor, of his ability to destroy the glory of Britain's walls of oak, to the hour when, as we shall see later on, the Lords of the Admiralty sent their last message of defiance in the announcement that they would have none of his *Destroyer*, and that the wisdom that rejected the propeller and the monitor still survived at Somerset House. There, the influence of naval predilections and opinions is supreme. The only argument able to gain access to the nautical mind is the argument of experience, and not even that, if this experience is

not in the line of established sympathies. This argument is impossible on behalf of new things. Hence it is that England retains the reputation she has always had, and which she shares with America, of being singularly unprepared, for a nation so intelligent and wealthy, at the outbreak of war, when new devices and new methods are certain to make their appearance.

CHAPTER XXIV.

RÔLE OF THE MONITOR.

Ericsson Declines to be Paid for Monitor Inventions.—Letters from the Prince de Joinville and Admiral Spencer, R. N.—Threat of War with Spain in 1878.—Monitors again in Demand.

THOUGH the *Miantonomoh* astonished the Englishmen by crossing the Atlantic and knocking at their front door, and the *Monadnock* made a successful journey of fourteen thousand miles around Cape Horn to California, it was not Ericsson's idea that the monitors should be employed for cruising. These vessels he tersely described as rafts with an impregnable, revolving, cylindrical iron fort above, and capacious, water-tight, ship-shaped bags below. They had accomplished the purpose intended, and it was expected that their rôle would be limited to home defence. Their designer was satisfied with their performance along our coasts, where they were engaged with forts a greater number of times than any other vessels ever built, and encountered weather of all sorts without danger.

The originator of the monitor system held from the beginning that the use of canvas was incompatible with low freeboard, though he so far yielded to the wishes of the Navy Department as to propose a scheme for carrying canvas in the *Dictator*. In the diagram on page 95, two American monitors, *Dictator* and *Kalamazoo*, are contrasted with two British armored ships, built by Sir E. J. Reed, Chief Constructor of the English Navy, under the influence of monitor ideas and monitor experiences. "The year 1863," as Sir Thomas Brassey tells us, "is remarkable in the annals of iron-clad construction for the laying down of the *Bellerophon*, which represented in a more complete form the various ideas with which Sir E. J. Reed had inoculated the Admiralty.* A section in outline

* Brassey's British Navy, vol. i., p. 86.

of the armored portion of this vessel shows a single-turreted monitor, with its sides rising so high out of the water (higher freeboard) as to compel a reduction in the thickness of armor, to keep it within the limits of weight. The influence of the monitor idea on foreign construction is more distinctly shown in the diagram on page 97. The *Thunderer* and *Inflexible* were English mastless turret-ships, of type entirely different from anything preceding them and confessedly suggested by the *Dictator*. The *Duillio* is an Italian citadel-ship, launched in 1876, and completed in 1880. Thus, eighteen years intervened between her appearance and that of the original *Monitor*. To meet the rapid advance in the power of artillery greater thickness of armor was required, and this, it will be observed, was obtained by concentrating the armor upon a sort of monitor construction in the centre of the vessel, leaving the rest of the ship exposed. The departure shown in the foreign vessels from the simple monitor idea of a single-turreted battery, designed for fighting purposes alone, was a necessary concession to nautical ideas. A complete adherence to the type, even in our own navy, was only possible so long as Ericsson had control.*

While he insisted on the completeness of his system, he was ready to accept suggestions as to the modification of its details, made by those who had had actual experience with his vessels. It was not always easy, however, to sift valuable suggestions from the mass of crude conceit and prejudiced criticism so worrying to one occupied with labors that were to the last degree exhausting. During the first trial of the new vessels in Charleston Harbor, the workings of the turrets were interfered with by slight derangements, resulting from the rough handling of battle, and requiring only minor modifications in the details of construction to prevent them in future. Though many of these were so slight that they were easily corrected by the use of a hammer and chisel for a few hours, they were sufficient to condemn the whole system in the eyes of eager critics, in spite

* It is a curious fact that the latest type of French armored vessel, the *Trehourt* class now building (1890), with their "turtle backs," come much nearer in appearance to Ericsson's original idea of 1854 than anything here shown.

of the fact that all the vessels reported for action the next morning. These critics were finally silenced, if not convinced, by the spectacle of monitors engaging the batteries again and again without receiving serious injury, though they were hit hundreds of times, every square foot on some of the turrets exhibiting the effect of shot.

A letter addressed by Ericsson to the Secretary of the Navy shows how he was accustomed to deal with the alarmists in the Navy whose faculties found full play in criticising to the minutest particular craft so opposed to ship-shape ideas:

The action of the sea under the extreme ends of our iron-clads, which experienced admirals and gallant captains look upon as an insurmountable difficulty, dwindles down to something not at all beyond computation when subjected to the investigation of the experienced engineer. Vague and extravagant notions of the force of the turbulent element soon lose their terrors when tested by the unerring standard furnished by hydrostatic and dynamic laws. When told of the fearful beating of the *Passaic's* projecting bow against the sea, and the angry surge that follows, the reflecting engineer, so far from being disposed to join Captain Drayton in his advice to give up the principle, calmly sets to work and estimates the actual force expended and the amount of resistance needed to meet it. Encouraged by the fact that a score of badly driven rivets suffice to arrest the assumed irresistible power and prevent the instant tearing away of the armored projection from the body of the vessel, he times the descent of the bow and compares it with the trifling altitude from which it descended. Having completed his investigation by noting the motion of the sea and measuring the surface under the bow, acted upon, he proceeds to calculate.

The comparative insignificance of the upward strain established by his exact calculation, shows in a conclusive manner why the *Passaic* did *not* cut the score of rivets, and part at the junction of the armor, immediately after the very first reported violent descent of her bow. It is hardly necessary to state, that by the application of a few tons of materials at the weak point of the junction of the overhang, an amount of strength may be imparted tenfold greater than at present.

I beg that you will not deem it irrelevant if I call your attention to the fact that, when I proposed to the British Admiralty, in 1838, to apply my screw propeller to ships of war, the most experienced men in the Navy vehemently protested against the application, asserting that the weight and action of the propeller would wreck the stern. We now apply heavier propellers to vessels of two hundred tons burden than I then proposed for frigates! Yet, sir, those professional gentlemen who then opposed me, saying that the ship's stern could not sustain

the weight of the propeller and the action of the sea upon it, were as experienced as the distinguished officers who now advise you to discard the new system because a mechanical difficulty has presented itself, which was *not at all guarded against*, and which our engineering resources have not been drawn upon—much less exhausted—in overcoming.

I have the honor to observe in conclusion that, with the experience gained, the resources of modern engineering will be applied without stint to render the *Puritan* and the *Dictator* perfect and as far superior to the present European fighting ships as the screw frigate is superior to the former sailing man-of-war.*

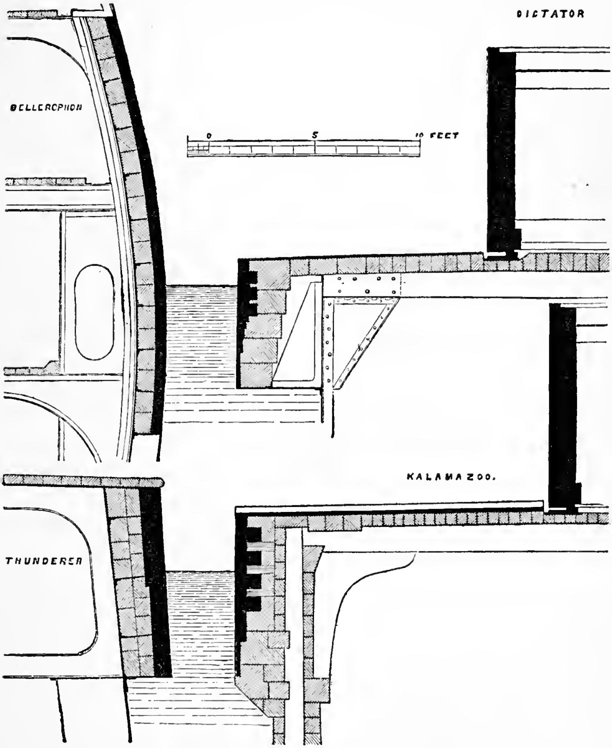
During the excitation which attends the exercise of the creative impulse, the imagination is active and the critical faculty is in suspense, and intelligent criticism is most useful to the worker, enabling him to at once judge his performances, as he will judge them when the state of absorption in his own ideas has passed. But so much of the criticism to which Ericsson was subjected through life was either prejudiced or ignorant, that he grew into the habit of disregarding professional opinion as of little or no value to him. Again and again he found his progress checked by officials who could only be moved to activity by the stern command of immediate necessity, and who had no wish to be disturbed in their comfortable routine by seekers after improvement. Changes involve risks, such as the dwellers in high places are not inclined to take, and the necessity for a new education in professional matters. To this the average army and navy officer is not disposed, and the units in military bodies are controlled by the influence of the mass. However enterprising the individual, the general sentiment of the class discourages exceptional activity and zeal for improvement; the traditions of the service are opposed to any departure from routine, and to the individual initiative; capacity counts for less than rank and position, and the ignorance of chiefs is more influential than the knowledge of subalterns.

Before the first monitor was completed, Commodore Smith suggested that Ericsson's improvements on the turret principle were subject to patent, and that if the Government used them in other vessels he would have a claim for its use. Isaac Newton wrote: † "To construct vessels on the Ericsson system is more

* Letter to the Honorable Gideon Welles, January 10, 1863.

† December 2, 1864.

than hewers of wood, and guessers at within two feet more or less of their displacement, can stomach. Do not think that the whole United States iron-clad navy is to be built on



British and American Turreted Vessels Contrasted.

the Ericsson system if they can help it, or cannot at least rob you of the fame connected with it; hence my reason for asking you to patent the whole concern from one end to the other, so that 'he who runs may read.' As for any justice from the

Navy Department or Government, they would not turn their hands over to assist you either in reputation or pocket."

Ericsson did not heed this well-meant advice, and he was subsequently able to say, in answer to an inquiry, "I have not received any remuneration from the nation for the *Monitor*, nor did I patent the invention, as I intended it as a contribution to the glorious cause of the Union." * His profit upon it came to him as one of the contractors for building the vessel, and not as an inventor.

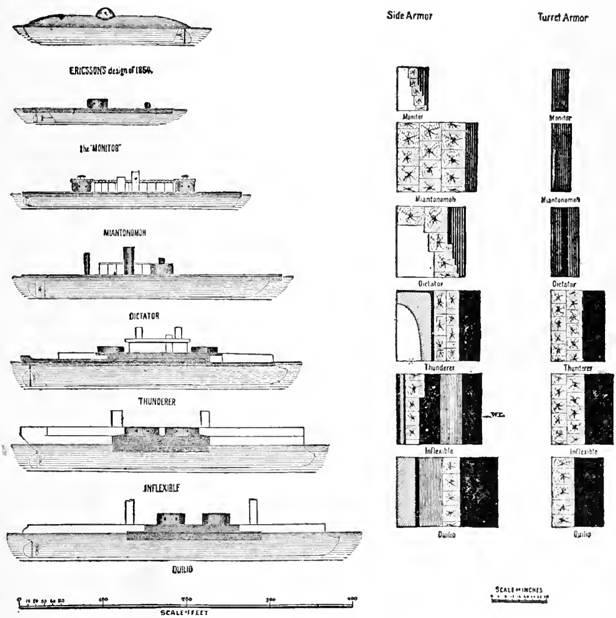
When in 1882 Senator Platt, of Connecticut, proposed to secure from Congress some recognition of his services, he replied: "Nothing could induce me to accept any remuneration from the United States for the monitor invention, once presented by me as my contribution to the glorious Union cause, the triumph of which freed four millions of bondsmen." In a similar generous spirit Ericsson declared in 1869, in writing to his London agents to secure for him a patent for improvement in ordnance, that his sole object for applying for this patent and for others connected with naval defence, was to put the inventions on record as being the result of his labors and research. "I do not seek emolument," he told Bourne in 1866; "what I desire to see is the monitor system adopted by that great power which my native land looks to for assistance in a contest that will take place sooner or later." At the same time he was naturally annoyed because a marine engineer was paid $40,000 for the device of a hydraulic lift for the monitor turret, when he received nothing for the turret itself or for numerous other inventions used by the Government.

Ericsson always insisted that his vessels should be fought end on in a naval engagement, so as to avoid the risk of being run down; to sink the adversary, if possible, by a sharp thrust from the iron beak of the monitor, and in fighting forts to present the smallest possible surface to the accurate fire of the stationary guns. In this way, too, the inaccuracy resulting from rolling in a seaway could be escaped, the angle of inclination of the gun-carriages in the turrets under such circumstances being less than seven degrees, 3½ degrees above and below the horizon; not sufficient to overcome friction and move the guns

* Letter to the Evening Herald, Syracuse, December 11, 1882.

out of position, as the angle of repose between iron and iron is nearly eight degrees. When the ordinary ship rolled its ports under water, the commander of the *Monitor* craft, by simply directing his battery over the bow, defied the disturbing influence of the heaviest rolling.

In harbor defence the light draught of the monitors enables



Development of the Monitor Idea.

them to run into the shoal water at the sides of the main channel, as the original *Monitor* did when the *Merrimac* undertook to ram her. From this coign of vantage such vessels could bring their heavy guns to bear, and in defiance of superior size and weight, sink the intruding iron-clad. The boast of the advocates of the broadside ships, that they could run down the

monitors, was made in forgetfulness of this fact, and of the further fact that such raft-like structures are more difficult to sink than high-sided vessels, while the overhanging sides pro tect the hull from the beak of a ram.

Among others who have expressed their opinion of Ericsson's system of naval construction is that distinguished naval authority, the Prince de Joinville. He was a lieutenant in the navy of France as early as 1836, a rear-admiral in 1840, and his special study of American matters as a participant in our Civil War gave him a familiarity with our war history that few Europeans possess. Writing to Ericsson as late as January 10, 1876, he said:

> I remember well our talk when I met you coming back from the fight at Hampton Roads, and how I went down on my tender and remained with Goldsborough on board of the *Minnesota* all the time the landing of McClellan's troops appeared a tempting bait, in the hope of seeing the fight renewed. Your *Monitor* was a stroke of genius and an immense stride in advance of everything at that time. For attack and defence in shallow water it has not yet been surpassed.
>
> I believe, too, that the turret and revolving gun system will establish itself on board of any kind of ship of war, but I am among the unbelievers in the continuance of sea-going plated ships. The sea remains the sea, and ships must be able to live in a storm. The unwieldy monsters of the day are unable to do it. They may be destroyed by a miserable torpedo carried by one man in a single boat. The smallest blow from the smallest ram can send them to the bottom. And there will always be a gun to pierce their armor. All this is absurdity; it cannot last. All sailors, like the knights of yore, will throw away the cumbersome cuirass that will embarrass and give no protection. Very wise indeed was your Navy Department not to launch itself in all these foolish and costly experiments about sea-going iron-clads. I always take great interest in all that happens in your great country, second only to my own in my affection.

The doubts as to the heavy iron-clads have not yet been dispelled by further experiment and investigation. Ten years after De Joinville, a distinguished British officer, Admiral Spencer Robinson, formerly Chief Constructor of the British Navy, writing to Ericsson on the same topic, said:

> It is, as I know, the merest commonplace to say that we wish that the progress of science would take another direction, that the wonderful

ingenuity of man could be exercised as successfully in promoting the happiness and well-being of humanity as it has been powerfully developed in the art of swift, sudden, and horrible destruction of the species. But this is not the millennium. Violence, Robbery, and Wrong too often and too largely guide the so-called statesman of the world to permit us to neglect any means which science and knowledge put before us to use in self-defence, and enable us to make the just and righteous cause prevail. Under these restrictions, I think nothing better adapted for the geographical position of that mighty nation stretching from ocean to ocean than the combined system of monitors and torpedoes.

In response to the attempt to show that the monitors were mere "clever makeshifts," Ericsson insisted that the resources of science had been exhausted in the endeavor to supplant his vessel by some one of another type. It was to be superseded, as he believed, only as all sea-floating iron-clad structures may be said to be superseded, by his system of subaquatic attack by little vessels fighting at close quarters. He was sustained in his belief by the opinion, expressed by the judges on naval structures at the conclusion of the Paris Exhibition of 1867, "that a monitor with a single turret and unencumbered deck, is the most perfect structure for naval defence."

The monitors in our service during the Civil War successfully weathered the fearful gales on the inhospitable shores of North and South Carolina during two winters, each vessel having been engaged on an average twenty-five times with batteries mounted with the most formidable European ordnance of that time, sometimes at a range under five hundred yards. Monitors built a thousand miles away fought in the Gulf of Mexico, cruised off Cuban ports in search of Confederate iron-clads, and, as we have seen, whenever they encountered them either captured them, as in the case of the *Atlanta;* or destroyed them, as in the case of the *Tennessee* and the *Nashville.*

On more than one occasion Ericsson felt called upon to turn aside from his work of constructing monitors to engage in their defence against the assaults directed against them in the press. Some of these had their origin in ignorance, some in prejudice, and others in hostility to him or to the administration under whose orders he was acting. Once he so far departed from his usual course of action as to send to the editor of one of the leading New York dailies a transcript from his

cash account, showing the various sums he had been called upon to "lend" to the author of its articles on the *Monitor*, and making it clear that his hostility was due to a refusal of further loans. The offender was promptly dismissed, and transferred his scheme of operations to another sheet. From this he disappeared on receipt of another letter from Ericsson, to renew his assaults in a third journal.

At one time there was a specially virulent attack, of which Secretary Welles wrote to Ericsson (August 11, 1864):

This concerted attack upon the monitor, or turreted class of vessels, by the New York press has an object beyond the Navy proper, though availing itself of the prejudices of such naval officers as are inimical to improvement or innovation. I trust, my dear sir, you do not permit them to annoy you. They say the monitors are built especially to attack batteries, whereas the primary object is defensive, and when a foreign war seemed imminent, and there were apprehensions from the *Alabama*, *Florida*, etc., in New York, the authorities of that and other cities, the Governors of the States, with Committees from the merchants and others appealed to the Department and Government for iron-clads to protect them. Such would be the case again were we threatened with a war with a maritime power. My confidence in the monitors has never been impaired from the beginning. Without alluding to their other qualities, they will constitute the true and reliable defence of this country in the future from maritime aggression.

Fourteen years after this letter was written, Mr. Welles's prophecy that the monitors would again be in demand were a foreign war again to threaten, was justified.

In 1875 war with Spain was imminent. The insurrection in Cuba had then lasted some seven years, and was accompanied by a constant series of aggressions on the rights of person and of property of citizens of the United States. The United States felt compelled to adopt a course of action which, in the event of Spain's resenting it, made war almost inevitable.

In a letter written to George M. Robeson, Secretary of the Navy, December 31, 1878, the Honorable Hamilton Fish, late Secretary of State, said of the condition of things at the time referred to:

Although Spain professed, and had on frequent occasions given evidence of, a desire to repress these aggressions, and to redress them, the

weakness of her government, with the Carlist insurrection on her hands at home, and the Cuban insurrection in the colonies, with the frequent disregard of her orders by the colonial authorities, together with her own traditional habits of procrastination, prevented repression, and the condition of her treasury prevented full redress; while designing men were instituting acts of wrong against our Government and people, with a view to irritate both Government and people, and to precipitate them into war.*

"There was every expectation that our Government would be obliged to interfere and stop the war in Cuba at the time, for official notice to this effect had been sent to Madrid, and the Governments of England, France, Germany, and Russia were asked to join in this intervention. Every available vessel of the Navy was concentrated at Port Royal, including such monitors as were in repair. The utmost haste was made to put in condition the others. "I thought then," testified Secretary Robeson before the Committee on Naval affairs, "and I think now (January 16, 1879), that with those vessels properly repaired and put in efficient condition, we would have had a sufficient iron-clad fleet for the protection of our shores and harbors; not an iron-clad fleet that could go abroad, as an aggressive force, but a fleet sufficient for the defensive purposes of a peaceful nation like our own, living upon our own continent, isolated from the powerful governments of Europe."

That there was such mounting in hot haste at the time that war with Spain threatened, was due to the neglect of the precautions Ericsson had advised at an earlier date. The science of naval gunnery made rapid progress after his vessels were completed, and experience had made it clear that the armor of thin plates interposed one upon another, which he was compelled to use, was much inferior to the armor composed of thicker plates such as the rolling-mills at a subsequent date were able to furnish. Accordingly, he advised that the monitors should be hauled out of water and thoroughly repaired, solid armor being substituted for the laminated plating. The monitor fleet was reported by Admiral Farragut to be in perfect working condition at the end of the war, and would have

* Testimony taken before the Committee on Naval Affairs, January 15, 1879.

continued so if the vessels had been taken out of the water and their bottoms repainted, instead of being left subject to the corrosive influences which, even in fresh water, will in a short time prove destructive.

"Placed on land and properly taken care of," said Ericsson, "the machinery put in motion, say once a year, vessels like the monitors are good for *fifty* years." Even the unfortunate light-draughts, he contended, with their turrets strengthened by solid plating, might be made useful for harbor-defence vessels, "for, be it remembered," said he, "such vessels need not have great speed. The work to be done by them is that of attacking the enemy's ships, not on the coast, but after the entrance of the hostile vessels, while taking up a position in the interior of the harbor." Continuing, he says: "It is hardly necessary to observe that at the present moment the English iron-clads, in spite of our forts and 15-inch guns could steam up to the Battery. Protected by iron netting, which the English have lately devised for harbor attack, our proposed torpedo boats, with their twenty feet long poles with a powder bag at the end, would be laughed at by our assailants; nor would stationary torpedoes prove any protection against an enterprising enemy employing mechanical means for destroying these contrivances and clearing and buoying the passage as he advances. Permanent obstructions defended by forts or monitors can alone offer effective resistance.

"No doubt a stationary torpedo, suspended in the channel at a proper depth below the surface of the water, is a dangerous obstruction, but we must not shut our eyes against the obvious fact that these structures are of such a frail character that they may be easily destroyed. Far different is the defence offered by a monitor, with an impregnable turret protecting guns capable of firing heavy projectiles and explosive shells, against the enemy's hulls below water-line. No other system of defence can compare with the monitor, which cannot be run down by sea-going iron-clads, as the light draught enables it to lay in shoal water by the side of the channel, from whence, without fear of molestation, the approaching ships may be attacked while entering a harbor. Should this attack fail, the monitor can leisurely follow the intruder and sink him while tak-

ing up the last position and preparing to shell the assailed point." *

At the close of the war the armor-clad fleet was laid up in the waters of the Delaware, at Philadelphia, presenting a singular and imposing spectacle as the creation of two short years, finding no parallel in military and naval annals; exhibiting such a sum total of destructive energy as no one could have imagined possible a few years earlier. Two years later Ericsson informed a friend, who thought of visiting this place, that he would then find "a fleet of iron-clads subjected to the most rapid decay. All that rotting and corrosion can do to destroy the vessels of which the nation expects so much in case of need, you will," he said, "find in active progress." In answer to a request from the Navy Department he had written, in March, 1866, showing how the armor-clads might be floated into an enclosed basin at League Island, when the water could be pumped out until it was needed to float them again. "A fleet laid up as I propose," he said, "is good for half a century, all excepting some repairs about the armor backing. Engines, hulls, boilers, etc., may be kept in perfect order, and in twenty-four hours fifty iron-clads may be transferred from their dry resting-place on the surface of League Island to the Delaware with stores and ammunition on board."

* Letter to William C. Church, dated February 19, 1872.

CHAPTER XXV.

RIVALS AND IMITATORS.

The Monitors of the British Admiralty.—Money Wasted on the British Navy.—Tragic Results of Cowper Coles's Rivalry.—Letter from Mrs. Ericsson.—Claimants for the Monitor.—Jonah the First Submarine Navigator.

MR. JOHN BOURNE, who devoted himself to the propagation of the monitor idea in England, was indefatigable, and determined that his countrymen should have the advantage of Ericsson's system and of Ericsson's services. Ericsson was willing to assist, with the stipulation, as he informed Mr. Bourne, that he was not to be put in the position of interfering with any plans of his friend Fox, who also had an idea of introducing the monitor to Europe, more especially to Prussia. Ericsson was willing to assist Fox, as he proposed to assist Mr. Bourne, without considering the question of pecuniary return for himself. No man was more indifferent to money for its own sake. Assured that his own moderate wants were to be supplied, he had no concern as to who might profit by his brains and his industry.

Taking advantage of one of those changes of administration so common in England, Mr. Bourne wrote (July 10 and 23, 1866) to the successor of the "First Lord" who had answered him so cavalierly when he approached him on the subject of monitors. He showed, by a reference to American experience, that the thickness of armor it was intended to use in England was entirely inadequate, and as the inevitable result of carrying out the Admiralty plans the work would all have to be done over again. He pointed out "that the use of laminated armor was not essential to the monitor system," and that the "immense disadvantages" of artificial ventilation were imaginary. "I am," he said, "about to urge its adoption upon the Peninsular

and Oriental Company for their steamers in the East, where every expedient of nautical ventilation has long been tried with very imperfect results."

Mr. Bourne based his conclusions upon the fact that he had given more attention to the subject he discussed "than any other engineer in England." He informed Sir John Packington that John Penn, the eminent engine builder, who was "well able to judge of Captain Ericsson's talents," was ready, if invited to do so, "to construct engines after Ericsson's designs." He urged the importance of giving the monitor system a trial, "with all the advantages consequent upon the co-operation of its author, who is not only the very ablest engineer probably of the present day, but who has been able to mature his system by the aid of the lights afforded by experience in actual war."

Warned by Ericsson, Mr. Bourne added that his principal "would not be disposed to make any official tender of his services, as he does not wish to press them upon anyone, or to subject himself to the slight of official repulse."

This letter was written before Sir John had entered upon his official duties; so a little later (September, 1866) Mr. Bourne made a formal request, in a letter addressed to the Secretary of the Admiralty, that he might be allowed, in conjunction with some approved English manufacturer, "to tender for monitors," believing "that the result would be to produce vessels that were quite unrivalled in the world."

This was written at the suggestion of Mr. E. J. Reed, Chief Constructor of the British Navy, who had shown a friendly disposition, expressing his regret that he was absent when Mr. Bourne's offer was sent to Whitehall, and saying: "I also very much regret that the most liberal offer of Mr. Ericsson has been declined. I certainly should have accepted it had the matter rested with me." (Letter of June, 1866.) Calling upon Mr. Reed September 2, 1866, Mr. Bourne was shown designs for turreted vessels prepared by Mr. Reed himself. Conscious that he was treading on delicate ground, Bourne yet ventured to suggest that the matter of adoption of these designs was of great importance to the reputation of Mr. Reed, as well as to the interests of the country. Hence he urged they should be kept out of sight until their author had an opportunity to sub-

mit them to Ericsson. "Mr. Reed, on this, expressed a desire to go over to America to consult you." Bourne wrote. This desire, as the result shows, was not acted upon. At the interview he describes, Mr. Bourne proposed to make a tender for monitors, to be built from plans submitted to Ericsson for revision. "This arrangement," as he reported, "Mr. Reed at once jumped at and recommended to me to write a letter to the Admiralty at once. A draft of such a letter was made, approved of by Mr. Reed, and sent to the Admiralty."

"Whatever the result," said Mr. Bourne, "I shall always feel it to have been a privilege to have been able to discern and proclaim the superior qualities of the monitor system over anything we have been able to produce in this country, and also to have been placed in correspondence with one whom I cannot but recognize as the leading spirit of the age in the engineering world."

In November, 1866, after the visit of the *Miantonomoh* had had its full effect, Bourne reported that he found no one in England who would "venture to stand up against the monitor system. In common," he said, "with all innovations, it had had its opponents; but never was there any innovation so completely under the dominion of pure reason, or one the efficiency and advantages of which could be so conclusively demonstrated." In his subsequent arguments with Mr. Reed, Mr. Bourne insisted upon the use of armor thicker than the 12-inch; he intended to adopt 18 inches and 24 inches.

The use of such heavy armor, as he very well knew, involved all the other details of the monitor construction. The result showed that, to escape this dilemma, the English and others were willing to leave a portion of the surface of the armor-clads exposed to penetration; sacrificing the protection Ericsson insisted upon, rather than antagonize the ideas of British sailors as to what comfort demanded. It is curious how, in the cycle of change, this element of comfort, so essential to those whose life is on the sea, has again been sacrificed to the imperative necessities of war. A son of the Prince of Wales, in command of a modern torpedo boat, during the inspection or manœuvres, in the summer of 1889, was obliged to occupy with two others a cabin ten feet by twelve.

Mr. Bourne was too confident: It was not until more than a year later (March 7, 1868) that the London *Times* was heard declaring that "the final blow had been given to the already tottering theory of broadside iron-clads." "Why," it is then said, "do we obstinately refuse to build small iron-clads, single-turreted vessels, with low freeboard and one or two guns of the heaviest calibre. The American and Russian officers who have actually tried them, report with enthusiasm of their sea-going properties. It seems to us that the Admiralty have in nothing so neglected their duty as in failing to provide us with a large supply of these formidable little vessels."

Mr. Bourne read before the Institution of Civil Engineers a paper on Monitors, and was awarded therefor their Watt medal and Telford premium. This paper started a discussion, and during this Mr. Reed produced his plans for the *Devastation* and *Thunderer*, both mastless, armored, sea-going turret-ships. Of these British ships the *Dictator* and *Puritan* were confessedly "the progenitors." In his elaborate work upon the British Navy, Sir Thomas Brassey says "the American monitors, *Dictator* and *Puritan*, were certainly the progenitors of our *Devastation* type." * This type was not adopted in England until 1869, or seven years after the *Dictator* had been put in hand. It was especially commended by the British "Committee on Design," composed of the ablest naval officers and most eminent engineers, and was then regarded "as the type to which all first-class fighting ships would have to approximate in future."

In 1864, two small monitors, the *Scorpion* and the *Wyvern*, were constructed in England for the Confederates. These were seized by the English authorities and subsequently purchased by the British Government. Being the first monitors built in England, they were inferior to the American ships, but their trials gave fairly satisfactory results, and led to the construction of two larger turret-ships, the *Royal Sovereign* and the *Prince Albert*.† These vessels were inferior in every respect to the Ericsson monitors. The *Wyvern* rolled twenty-two degrees, so that she was unable to work her guns in a seaway.

* See The British Navy, by Sir Thomas Brassey, vol. i., p. 134.

† Ibid., p. 16.

The *Royal Sovereign* was an old three-decker, originally pierced for one hundred and twenty guns, and altered to test the theories of Captain Cowper Coles, the officer of the British Navy who sought to appropriate the honors due Captain Ericsson for the *Monitor*. The *Prince Albert* was a new vessel built after Coles's plans. As has been seen, Mr. Reed, Chief Constructor, had the good sense to oppose the adoption of the ideas of Captain Coles and to favor those of Ericsson. But in his *Devastation* and *Thunderer* he, too, sought to improve upon Ericsson, departing in essential particulars from the monitor idea of substituting concentration for diffusion. The result was that, long before these vessels were finished, guns appeared that could pierce their inadequate armor through and through.

In 1877 Mr. Bourne said:

> If Ericsson's aid had been obtained, our Navy would have been in a very different position at the present moment from what it is actually in. Millions of money would have been saved to the state, and the nation would have felt itself secure, instead of being oppressed by the conviction that all we have hitherto done in the way of armored vessels is futile and unavailing, and on the outbreak of war we should find ourselves to be virtually defenceless. At present our Navy is a by-word. Our sailors are, no doubt, as good as ever. The fault is in our ships, and is traceable to the fact that in a great transition period we have had no leading mind competent to direct the course of the transformation.
>
> Lords of the Admiralty are, as a rule, incompetent to appreciate such men as Ericsson, or even to discern the need of a great genius to successfully work out great innovations. Left to themselves, they are content with worn-out methods and with the counsels of stagnant mediocrity, and are utterly powerless to devise a course of action when some new difficulty has to be confronted. It is under such circumstances as those which have prevailed since the introduction of armor-clads, that the aid of such a man as Ericsson—confessedly the greatest engineering genius of the age—becomes of incalculable value; and the stolidity which neglected to avail itself of his aid while still accessible, must ever be reprobated and lamented. . . . At present this much at least is clear, that, spite of so large an expenditure, we have no efficient shot-proof navy, nor have we any military instrument yet matured and available to act as a substitute. Our naval authorities are confessedly at sea.*

Naval authorities are quite as much at sea now as they were then, and England continues to build at an enormous ex-

* The Past and Future of Ships of War, by John Bourne, C.E.

pense vessels which the first naval war will render obsolete; for no other apparent reason than that other nations are doing the same. She craves two ships to every one possessed by any other nation, and it is the theory of British naval authorities that they must be prepared to resist a combined attack from any two naval powers.

After much discussion Captain Coles had succeeded, in 1869, in persuading the Admiralty to build a vessel more exactly representing his ideas than those previously constructed. This was a vessel of 4,272 tons, completed at a cost of nearly two millions of dollars. In this Coles undertook to combine a great spread of canvas with low sides. By an error in his calculations the vessel had two feet less freeboard than he intended, her deck being only six feet above the water-line, instead of eight, as proposed. She was completed in 1870, and on the 7th of June in that year Mr. John Laird, who had built her, said, in a letter to Ericsson: "I send you a paper to-day with some report of the cruise of the *Captain* with the fleet. All that is said in the paper is confirmed by letters from officers on board the vessel. One night they had a strong gale and wind at force 10, and the ship lay under close-reefed main-top sails and reefed foresail. She was pronounced by all on board to be the most perfect sea-boat they were ever in. She tacks, stays, wears, and works as well as any old line-of-battle ship, and my correspondent adds that 'the way in which this ship works and answers her helm is most striking.'"

Mr. Laird's correspondent on board the *Captain* would appear to have been her enthusiastic designer, Cowper Coles himself. Toward the close of 1870 the *Captain* made one or two successful cruises. "The excess in her draught of water was not considered serious, and as she appeared to be a good sea-boat no notice was taken of it. Her stability was never doubted by her designers; nor, indeed, was her critical state ever properly realized by anyone; any doubt that may have existed was smothered by the confidence of her advocates. The chorus of praise which she elicited on all sides continued to increase, and the question as to what the type of the British war-ship for the future should be was supposed to be settled in her beyond dispute."

Then came the dreadful news that she had gone down, during the night between the 6th and 7th of September, 1870, off Cape Finisterre. The wind had not been unusually violent; the sea had not been exceptionally heavy; there were no extenuating circumstances; she had not bravely battled with even ordinary rough weather; she was proceeding confidently under steam and sails when, in an ordinary squall, she displayed once for all her subtle and treacherous character by slowly turning over and becoming the coffin of nearly the whole of her crew, some five hundred men, including a large number of accomplished officers. The people of England were almost panic-stricken at this terrible news. How it could have occurred with the comparatively wide-spread knowledge relating to the subject and the facts and figures of her special case before them, it was difficult to conceive." * It was the disregard of hydrostatic laws shown by Captain Coles in his attempt to combine low freeboard with high sailing qualities that led to this disaster. "Low freeboard," said Ericsson, "unquestionably insures a steady platform for the guns, but if made as low as it should be to secure the great object in view, protection against shot, it is incompatible with sailing qualities. In fine, low freeboard is only applicable to the fighting machine, the genuine monitor."

Coles was ambitious to carry on his cupola vessel as much sail as a first-rate three-decker, and his spread of canvas and load of top-hamper were too much for a vessel having such small stability as the *Captain*. When last seen she was carrying royals, she was encumbered with a hurricane-deck twenty or thirty feet above the sea-level, and upon this deck were stored boats, anchors, and all the gear necessary to work the ship. This top-weight, in addition to two massive turrets of twenty-seven feet diameter and ponderous side-armor, was too much for a vessel pushed over beyond the line of safety by the leverage of her masts and sails. In the *Captain* was witnessed the application of the suggestions for supposed improvement of the monitor system constantly thrust upon Ericsson by influential advisers, and to which he opposed the strength of his sound judgment and his inflexible will.

* The British Navy, by Sir Thomas Brassey, K.C.B., vol. i., p. 346.

In the "Life of Sir John Burgoyne," father of the naval officer who commanded the *Captain*, we are told that she was looked upon as the acknowledged model of the war-ships of the future, and that most of the Government officials who had sons in the Navy had asked for appointments in her, and among her complement of officers she carried sons of Lord Herbert, formerly Secretary of State for War, Mr. Childers, the First Lord of the Admiralty, Lord Northbrook, the Under-secretary of State for War, Colonel Boxer, the head of the Laboratory Department, and Captain Gordon, the principal Comptroller at the Royal Arsenal. One of her lieutenants was Lord Lewis Gordon, a brother of the Marquis of Huntly, and as guests with her commander were her inventor, Captain Cowper Coles and a son of Admiral Sir Baldwin Walker, the former Comptroller of the Admiralty. At the special request of her designer, Captain Burgoyne had been selected to command her, and she had on board a picked crew, many of whom had volunteered for her owing to the popularity of her captain.

Over a tombstone in the parish church of Scole, Suffolk, England, hangs a boat-flag which drifted ashore from the *Captain* on the Bay of Biscay. It marks the cenotaph of her unfortunate designer. His fate and the fate of his vessel, so unprecedented in naval annals, are the best answer to the claims he presented during his life. In connection with the less melancholy, but even more costly, experience of the light-draught monitors, they emphasize, as no expenditure of rhetoric could, the wonderful mastery Ericsson possessed of nautical problems. The stupendous failures of others, who undertook the solution of the same problems, present his great success in sharper outlines.

Contrasting this experience with that of Coles, "the son of an old naval officer" * said:

Such, then, are the respective achievements of Coles and Ericsson in regard to the invention and construction of turret-vessels. But, apart from all recapitulation of the facts such as I have given, the presumption would certainly be, in any question touching the authorship of such an elaborate improvement, that it is to Ericsson, and not to Coles,

* Captain Coles and the Admiralty. London: Longman, Green & Co.

that we are indebted for it. It is no disparagement of Captain Coles to say that, until this turret controversy arose, his name had never been heard of out of his own domestic circle; and he makes no pretensions to mechanical genius, such as distinguished the late Earl of Dundonald, or even to any such commonplace acquaintance with mechanical resources as ordinary engineers and ship-builders must necessarily possess. On the other hand, Ericsson is known to be distinguished, not merely by remarkable inventive genius, but for the last forty years he has been stamped as one of the most skilful engineers of the age, and one who has all the qualifications necessary for working out his conceptions to a practical and successful issue. While, therefore, a perfect and efficient turret system would be too much to expect from Coles, it would not be too much to expect from Ericsson; all his antecedents and his known talents being such as to warrant us in expecting from him the highest measure of improvement that the present age can produce. . . . .

Not only is Ericsson a proficient mechanic, but an able officer of the Military Engineers; and in regard to the penetrating power of guns, and to a correct estimate of the resisting power, he had attained pretty near as much progress a quarter of a century ago (*i.e.*, in 1841) as we have reached in the present day.

From such a man the production of a new and more powerful system of armament and defence might reasonably be expected; whereas, nothing short of a miracle could enable an amateur mechanic, of slow imagination, and confessedly destitute of all practical resources, successfully to achieve such an important work.

The persistent writing and arguing and presenting of "claims" by Cowper Coles and his friends, did much to bring the monitor or turret system into discredit, at least in England, where it was confused with Coles's "cupola" system, to which it bore only a superficial resemblance. The idea of protecting guns by shields, as Captain Coles claimed, first occurred to him in 1855, the year after Ericsson's letter to Napoleon; but it is obvious that, whatever the idea was, Coles was unable to present it in practical shape until the *Monitor* appeared. Then he sought to graft his crude notions upon a system complete and perfect in itself. His punishment was dramatic in its promptness and severity.

Coles's misleading efforts to enlighten the public, with reference to the merits of a system he had confused with his own, gave Ericsson great annoyance, and they began as soon as the *Monitor* was heard from in Hampton Roads. A month

after her appearance there Mrs. Ericsson wrote this letter to her husband:

2 Canning Place, Kensington Gate, April 7th.

I send the *Times* in order that you may peruse the infamous attempt of claiming *your invention* as England's production. The time will appear to me an age before you can repudiate this mean and paltry assumption; but, of course, comparison of chimneys, etc., etc., which you must submit to Europe, can stand the test no doubt of your undivided claim. I think it is a pity you have no one here conversant with the invention to represent your interests. Would it not be worth while to have some agent here? It is disgraceful that others should stand up and *profess* to be the origin of this great crisis in warfare. It will seem an age to me ere you can possibly give refutation to Captain Coles's assertion. Still, I *feel* England will be again startled by the proofs you can undoubtedly bring to light of your *legitimate* claim.

With earnest desire that you may conquer your enemies here,

I am, as ever,

A. Ericsson.

As a matter of fact, every mechanical device connected with the system, so triumphantly vindicated under the stress of war, was the product of Ericsson's fertile brain. A fact the more remarkable, since, as I have shown, the exigency of the times did not admit of previous experiments, everything being despatched directly from the foundry and workshop to the field of battle. Contrast this with the mishaps and failures on the other side of the Atlantic! The *Captain* is the chief but not the only example. England wasted in experiment more than the United States expended in creating its entire monitor fleet, and in addition, at the end of our Civil War the mother-country had invested $250,000,000 in broadside vessels, and these, by the confession of the London *Times*, were rendered antiquated by our experiences with the monitors under the actual conditions of battle. Yes, *wasted* in experiment, for on this side of the Atlantic we had already settled the questions still in process of investigation by that body of gentlemen whose career has proved a cogent agreement, *a posteriori*, against the once mooted scheme for establishing an Admiralty Board in the United States.

While England, in spite of the protests of Bourne and others, was building its vessels with inadequate protection, and

conducting costly experiments to determine the resistance of iron plates, the destructive effect of fifteen-inch solid shot with sixty-pound charges had set at rest all speculation. Twelve and fifteen inches of solid iron were adopted as the standard, and such thickness of armor required the use of the monitor.

Cowper Coles was not alone in his assertion of priority, and his claim, if not established, was certainly as well founded as that of others on whose behalf the same claim has been presented. In considering these claimants in their order, it is proper to give first place to Mr. Charles Dudley Warner, as the representative of the Jewish prophet whose history furnishes the first recorded case of strictly submarine navigation. "Thanks to an enduring piece of literature," says Mr. Warner, "the unheroic Jonah and his whale are better known than St. Jerome and his lion. . . . He in a manner anticipated the use of the monitor and other submerged sea-vessels." *

So "in a manner" did Mr. T. R. Timby, for whom the monitor turret has been claimed, anticipate Ericsson, but no more than Jonah did he furnish Ericsson with the idea of a submerged vessel, with the turret as its visible and outward sign. True, Ericsson's associates, who were shrewd men of business, thought it worth while to invest a moderate sum in securing control of Timby's ideas, at a time when controversy was to be avoided. They sought afterward to make this purchase available by building land turrets for the Government on Timby's plan, but in this enterprise Ericsson refused to join them.

Writing to a friend, Ericsson said:

> A house, or turret, turning on a pivot for protecting apparatus intended to throw warlike projectiles, is an ancient device; I believe was known among the Greeks. Thinking back, I cannot fix any period of my life at which I did *not* know of its existence. A ship of war provided with a turret capable of turning toward any point of the compass, as in the *Monitor*, is, however, original with me. Many attempts have been made to deprive me of the credit of such a device, but they have all failed.

* In the Levant, by Charles Dudley Warner.

Timby's *revolving* turret is a totally different invention, presenting some advantages and many radical defects. It is a cylindrical iron citadel for harbor defence, with many floors, each floor carrying a large number of guns operated on fixed *radial* slides. Placed near the entrance of a harbor, it is kept continually revolving when the enemy is near, each gun being fired in succession the instant it bears on an unlucky intruder. Should the rotation by any cause be stopped, the whole structure with its numerous guns becomes useless, since each gun points unalterably in a different direction. Obviously, the grand idea is that of concentrated fire on an approaching ship, there being but a few seconds between each shot if the turret is turned rapidly. Timby having stated in his patent that the invention was intended "for land or water" (meaning, of course, that like many other forts it might be built in the water), claimed, as soon as the *Monitor* had proved a success, that I had infringed. My generous partners in the *Monitor* enterprise, desirous of securing an interest in the grand revolving turret, which they supposed would be employed to protect *every* harbor in the country, at once took Timby by the hand, and paid him a sum of money, partly taken out of my pocket. . Timby got his original patent reissued in such form that my disinterested partners imagined that they held my patent. Civil engineers of the highest standing at once prepared drawings of my friend's harbor defence turrets; but practical Lincoln, well advised by my friend Fox, could not see that the safety of the country demanded the immediate erection of Timby's turrets.*

Floating batteries, protected by heavy wooden bulwarks, to secure impregnability, have been resorted to in the naval wars of Europe for centuries. Ten such batteries were constructed by the Spanish Chevalier D'Arcon for his attack upon Gibraltar, September 13, 1782. Their wooden hulls were protected by bars of iron, and an outer covering or belt of cork. But they were not proof against fire, and with the aid of red-hot shot they were destroyed, five blowing up and five burning to the water's edge, only 487 out of 5,260 men being saved.

But none of the earlier protected batteries were monitors. Ericsson's vessel was a distinct and novel conception, showing a perfect unity of design, one part growing necessarily out of another, and the whole presenting the most perfect possible solution of the problem of securing the maximum amount of gunpower with the minimum amount of exposure for vessel and crew. The success of his system was dependent upon the feat-

* Letter to R. B. Forbes, November 29, 1884.

ures in which it differed from, and not on those in which it resembled, others. For himself Ericsson says:

The invention submitted to the Emperor of the French had engaged my attention since 1826; in fact, it has been the hobby of my life to destroy large ships of war by small, nearly submerged, and partially impregnable vessels. The idea of employing iron for this purpose dates back to the first conception. But the idea of casing large ships with iron I do not claim. In truth I have always been opposed to it, as a practical absurdity. Before the introduction of the modern leviathans I had fully demonstrated that ships could not be made shot-proof and retain sufficient buoyancy for practical purposes; hence, when Mr. R. L. Stevens proposed to protect his intended *steam frigate* with iron, I asserted that the scheme was impracticable. Captain Stockton, of the U. S. Navy, in 1841 asked my professional opinion on the subject, stating that Mr. Stevens's calculations proved that his proposed steam frigate could readily carry the weight of armor necessary.

To my query what thickness had been estimated, Captain Stockton said that Mr. Stevens had fully established the fact that 4½-inch thickness would effectually resist shot, and that accordingly his estimates were based on that thickness. I then informed Captain S. that on dynamic consideration a solid shot from a 12-inch gun, fired with a 30-pound charge of powder would, at short range, infallibly penetrate 4½-inch thick plating. A target was accordingly made of this thickness and placed before a 12-inch wrought-iron gun, fired at short range with the stated charge. The shot, weighing 224 pounds, pierced the target as easily as an ordinary boiler-plate is perforated by a powerful punch.

Mr. Stevens's calculations having thus been proven erroneous, the intended construction of an invulnerable steam frigate by the United States Government was postponed for many years, during which he made a number of experiments to ascertain the resisting power of wrought-iron plates of different thickness and placed at different angles to the line of fire. The result of these experiments, never published, demonstrated that the sides of steam frigates cannot, as supposed when the plan was first laid before the Government, be covered with armor-plates of sufficient thickness to resist heavy projectiles. At what period Mr. Stevens adopted the plan of partial submersion—intended to be applied to the vessel which he left half finished at his death—is not known. Nor does it appear that he had quite determined the strength of the armor, or the manner of applying it. Experienced engineers who have examined the intended *battery*, as it is called, are unable to understand how Mr. Stevens intended to support heavy armor on the exceedingly frail hull, the side plates of which are only ½ inch in thickness.

With respect to priority of invention, I have to say that, as far as

my knowledge extends, I believe that Mr. Robert L. Stevens was the first person proposing to protect the sides of war steamers with, or to build their sides of, plate iron sufficiently thick to resist shot. For my own part I disclaim having ever suggested such a plan, because during my earliest investigations I found that such were the conditions imposed by hydrostatic laws in connection with the strength and weight of materials, that absolute security against shot could only be attained by an almost entire submersion. The strange-looking craft which irreparably damaged the Confederate cause at Hampton Roads was built in accordance with those early views, which I have not, up to this time, had reason to change, although a fleet of fifty iron-clads have, in the meantime, been constructed in strict accordance with those views, and ample experience gained during numerous engagements with a skilful and well-armed adversary.*

A claim to the invention of the monitor, scarcely more absurd than the others, was contained in two letters sent to Ericsson, the year before his death, by a colored resident of Philadelphia. With evident sincerity he stated that, when he was a waiter at a New York restaurant in the first year of the war, he had folded a napkin and put it on the table by the side of a gentleman upon whom he was attending, and suggested the building of a gunboat like the model thus indicated. Subsequently learning that this gentleman was John Ericsson, he had presented his case to the Secretary of the Navy, who had advised him to write to Ericsson. "The late Hon. Robert Toombs," concluded this claimant, "said that the colored race had done nothing worthy of remembrance in the history of this or any other country. I can say I done much when I folded the model that prevented him and his party from destroying this greatest nation in the world."

True, emancipated brother, for if you have done nothing else, you have at least helped to present in proper light the absurdity of claims to Ericsson's invention, on behalf of men who were no more capable of developing the monitor in its entirety than were you with your folded napkin.

Antecedent to the war bringing the monitor to light, Ericsson had made more improvements in war-ships than any other man; improvements copied first by France and then by England, without acknowledgment. Whenever any emergency

* Letter to Bourne, January 16, 1866.

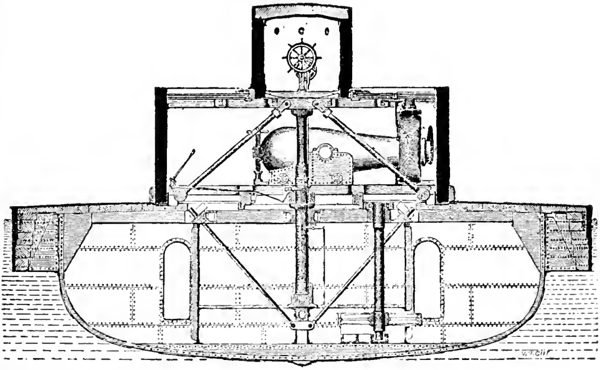
had appealed to him with sufficient power to direct his attention to the subject, he had devoted the resources of his great engineering mind to the development of naval science, and always with the most marked results. His claim to priority, therefore, rests, not only upon his own testimony and the documentary evidence he has presented in support of his statements, but on the strong presumption in favor of a man so exceptionally endowed as he undoubtedly was. As against Coles, this presumption, independently of testimony, is that Ericsson, of all men, was the one most likely to have invented the improvements in controversy. He had already given proof of the possession of the attainments required for such a task—one demanding an amount of engineering talent not to be expected in an ordinary naval captain.

Somewhat upon the principle that "he who drives fat oxen must himself be fat," many seem to reason that the men who sail our ships must of necessity best know how to build them. The theory has led to results as unsatisfactory as those which would follow the adoption of a corresponding delusion that architectural ability is developed by residence in fine houses. The best work on seamanship is credited to a dockyard clerk, who had never been to sea, and it may require other qualities than those found in our Paul Joneses and Farraguts successfully to develop that most complex of all mechanisms, the modern battle-ship.

The action at Hampton Roads brought most prominently into view engineering skill as one of the chief factors in modern naval success. Hence, when mechanical genius in some measure had its own way, the practical head of our Navy Department during the war, Captain Fox, was able to declare that the machine thus created was perfect for the work she was intended for, and was the only progressive creation of the war. On the other side of the Atlantic, that eminent authority, Mr. Scott Russell, speaking of the remarkable success of the original *Monitor*, as "a type of an entirely new class of war-ships," observes how differently the system was developed in America and in England. "In the one case the sudden abandonment of all the conventionalities of a ship, in the other the studious retention of old forms and ways, admitting the innovation with

the greatest possible amount of reluctance and seeming aversion, and hating a novelty whatever be its merits."

Instead of following out the lines laid down for them by the genius of the man who has created modern naval war, the Americans have, since released from the control of war necessities, occupied themselves in the supine contemplation of foreign creations, forgetting how many of the great progressive changes, even in the art of war, have had their origin, if not their development, on this side of the Atlantic.



Sectional View of a Monitor through Turret and Pilot-house.

CHAPTER XXVI.

SERVICES TO SWEDEN AND SPAIN.

The Defence of Sweden.—Letter to Secretary Seward.—The Swede's Lack of Ability as a Soldier.—His High Qualities.—Monitors and Gunboats for Sweden.—Ericsson Opposed to Naval Attack on Charleston, S. C.—A Cavalry Gun.—Insurrection on Cuba.—Ericsson's Aid Invoked.—Builds Thirty Gunboats for Spain.—International Difficulties.

TO the defence of Sweden Ericsson contributed liberally in money, inventive talent, large experience, and sound judgment. "But for your patriotic generosity," wrote Captain Adlersparre, of the Swedish Navy, "our first monitor would have had two 9-inch guns." Thanks to the generosity of John Ericsson the monitor that bore his name carried the most effective ordnance then afloat, the 15-inch Rodman gun. "If there is in heaven a special dwelling for patriots," wrote the warm-hearted sailor, "your place will certainly be in the state apartments."

Adlersparre described his solemn feelings when, during a voyage on the first Swedish monitor, he examined "this most perfect production of your creative genius which has had such a decisive influence in settling one of the greatest social questions, the abolition of slavery." He spoke of the anxiety he felt when he realized that the poverty of Sweden prevented the building of a sufficient number of these vessels, while their "enemies and neighbors, the Russians and Prussians," could have so many more. "Situated as we are," he said, "between these two engulfing powers, both alike dangerous and endeavoring to extend their dominion, this is a very critical situation."

These apprehensions were shared by Ericsson. "More," he said, "is known here, in certain quarters, than you are

aware of, respecting the dangers to Sweden which loom up in the immediate future. The gigantic Northeastern Empire, it is said—now that Prussia virtually commands the outlet of the Baltic—cannot permit a weak neighbor to present a permanent barrier to a direct communication with the ocean. A protracted war between France and Germany, it is added, will infallibly be taken advantage of, and Sweden be made a province of the great empire. England is no longer counted, and, to neutralize her waning power, desperate efforts are being made to secure America. Witness the overstrained attentions paid to a score of subordinates on a recent occasion."

Ericsson had no very high opinion of the Swede's ability as a soldier. "The young Swedes," he said, "require a longer training to become good soldiers than any people I know. The stuff is there, but it requires an inconveniently long time to bring it out. It was my business for years to train 'rekryter,' hence I know what I am talking about. An American lad will become a better soldier in a month than '*bondpoiken*' in two years. The subject has engaged my mind intimately for nearly ten years, the result of all speculations and considerations being a settled conviction that Sweden, with her small population, cannot be defended against Russia or Germany, excepting by *mechanical* means. This idea would be laughed to scorn if put forth, hence I will remain silent, hoping that my dear native land will not be attacked until the necessity of invoking mechanical aid is appreciated by my countrymen. I know full well that, should a determined attack be made before the truth I have enunciated shall be acknowledged and acted upon, Sweden will be blotted out from the map of Europe, as an independent nation."

Again he wrote, saying: "The Swedish nation has still many great achievements before it. I admire my countrymen and think most highly of the 'uncivilized Swede,' who has gained from every comparison I have made during my stay among other nations. I believe I understand the subject thoroughly, for as a *niveleur* on the Göta Canal I came in personal contact with a great number of the working class, and when a surveyor in the forests of Jemtland, my associations during several summers were exclusively with the sons of the

peasantry who were my assistants. It is with true satisfaction I now call to memory the time when I associated and exchanged thoughts with the energetic and hardy youth of the Norrland forests. Without disparaging other nations, I must say that the perseverance, sense of right, and clear heads of these youths place them far beyond the young men of the working class in the other countries I know. I estimate the Swedish vigor and innate good sense as beyond that of other nations."

As soon as he was released from his work upon the monitors for the American Navy, Ericsson turned his chief attention to the problem of defending his native land. "I love Sweden," he wrote to Mr. Seward, Secretary of State, "and would willingly sacrifice my life for her honor." "So exclusively have I devoted myself to the Swedish national defence," he said in August, 1867, "that I have not been out of New York for a single hour this summer." This shows how his mind was absorbed with patriotic work, though the experience, so far as confinement to his office was concerned, was no unusual one, for he never went from New York further than the opposite bank of the Hudson. He invented a special form of monitor for the defence of the Swedish coasts. This was a little vessel of 140 tons, so designed as to carry out the idea of fighting bows on, the turrets being stationary and oval in shape, thus presenting the least possible surface to the impact of shot. The pilot-houses were put aft, out of the line of fire. The machinery for the first one was presented by Ericsson to his native land as a pattern to be strictly followed. As Sweden was dependent upon imported coal, and her supplies would be cut off in the event of a blockade, it was so arranged that it could be detached from the propeller when required, and hand-power applied to turn the screw. A crew of twenty-four men could produce $7\frac{3}{4}$ horse-power at the maximum, and could maintain $5\frac{1}{2}$ horse-power for several hours. The Swedish sailors objected to this hand-work because of its resemblance to that of galley slaves, but as the emergency for which these vessels were intended happily never came, neither their patriotism nor their muscle was put to the test.

This idea of boats carrying a single gun, placed parallel with the keel and trained by the vessel, is an old one in Sweden, hav-

ing been adopted during the last century. Indeed, Swedish coast defence has, ever since naval ordnance was introduced, depended mainly upon gunboats propelled by oars. Ericsson substituted the propeller for the oars, placed the crew below the water-line, protected the gun against the enemy's fire, applied a small auxiliary steam-engine, and introduced a wheel at the bow for turning the vessel on her centre. His little craft were slow, but it was not intended that they should ever come within reach of an enemy. Creeping along the coast from inlet to inlet, and always in shallow water, they could not be run down, and could make their single heavy gun most effective in convincing an enemy that the Swedish coast was not a comfortable place for hostile cruising. They were described by their designer "as a combination of steam-power and hand-power," each *independent* of the other. When the coal gave out the "blue jackets" were to lay hold; thus the Swedes would be able to lurk for any length of time along the coast, watching their opportunity to have a pop at the hated Muscovite.

Had the Confederates been armed with such vessels at the outbreak of the American war, they would have found them of far greater value than their heavy iron-clads. The money spent on the larger vessels was wasted, as they were built only to be destroyed one after another. With these little monitors they could have effectually defended the Mississippi and its tributaries; perhaps prevented Farragut from capturing New Orleans, and sunk or burned the vessels of his fleet one after another; the story of the capture of Port Royal would not have been told; Grant's operations at Vicksburg would have been made impossible, and the blockade could not have been so efficiently maintained. The fate of the *Nashville* shows how effectively 15-inch shell could be used.

For Sweden, Ericsson subsequently recommended gunboats in place of more monitors. "The subject of naval defence," he said, "has engaged my attention for thirty years, during which time I have had unequalled opportunities of arriving at a correct conclusion in the matter. That conclusion is that a weak nation can defend herself only by gunboats." Four dozen 15-inch gunboats could, he thought, accomplish more

than four monitors, and they were less expensive. He gave the same advice to the Greek Chargé d'Affaires at Washington when he applied for advice as to the proper armament for Greece.

For the machinery of the first of the Swedish gunboats Ericsson expended some $6,000, and in a letter dated September 3, 1867, he mentions the fact that he had, up to that time, expended over 100,000 crowns on the defence of Sweden. "Nobody now living has given such proof of patriotism," wrote Adlersparre, "and no one of our ancestors has done more. You may be sure that the Swedish nation loves you and mentions your name with pride and enthusiasm; excepting only a few case-hardened generals and counts in the aristocratic first chamber, who cannot bear that anybody should be so esteemed as to eclipse their stupid self-conceit."

This was in answer to complaints from Ericsson that his disinterested purpose was not understood in Sweden, and was in danger of miscarrying because of the distrust and jealousy of the Swedish authorities. "With an adequate number of gunboats carrying 15-inch guns, we can," he said, "destroy an enemy's vessels, and infallibly defend our shores. Without the same an invasion could not be prevented, notwithstanding the expenditure of millions of riks dollars for cunning devices and traps; and notwithstanding millions of pounds of powder being hidden under water—to be removed or avoided by a skilful enemy."

In another letter, dated March 6, 1868, he warned Adlersparre against wasting money on fixed torpedo defences or torpedoes sunk in the harbor to be fired by contact or from the shore. Concerning them he made this interesting statement: "The assertion that *torpedoes* prevented the Union forces during the late war from capturing any desirable place, is simply untrue. Mechanical, positive *obstruction* and rope defences, suspended under water for entangling our propellers, we deemed formidable barriers. As to Charleston, our commanding general never desired its capture, as he had no means to hold it if taken—50,000 men would not have sufficed for that purpose. The whole scheme of capturing Charleston originated with Fox, but it was laughed at by most military men. I did all I could (probably all that was needed) to prevent the silly scheme

from being carried out. Had General Grant said to the fleet, 'Go in and bombard the city, *I* want it and can hold it,' the thing would have been done. I had, in expectation that such orders would come, contrived iron baskets, several of which were completed, for protecting the propellers from the sunken rope-snares. As to *torpedoes*, Admiral Dahlgren never for a moment hesitated to pay the city a visit on account of their existence. It was the piles and the rope entanglements which alone restrained him.

"Respecting Sweden, let me ask if the sinking of 10,000 torpedoes would prevent Russia from landing at some desirable point? The removing and destroying torpedoes is a mechanical problem of easy solution. Two or three iron-clads fitted for this purpose would make short work with your delicate torpedo gear (at the place selected for attack and landing) in a single day. Pardon me if I say that I lack patience to argue the point. Suppose you incur the expense of placing 10,000 torpedoes. The enemy will attain his end by removing less than five hundred. *You cannot prevent this*, you cannot protect your tender gear unless you possess fortifications so extensive that England's wealth would not suffice to erect the same. While thus you are watching and guarding your useless 9,500 torpedoes, the enemy will land and throw his whole concentrated force on the spot selected. Your army then must meet him, and if you have not a gunboat fleet, powerful enough to destroy his fleet of transports, he will pour in his overwhelming force and capture the country. Is not this a plain proposition? Abstain, then, from wasting your means on anything else until you have a fleet of at least fifty gunboats carrying 15-inch guns. This fleet equipped and ready to meet the enemy, then by all means resort to all possible auxiliary defences that your resources admit of, but not until the army has been provided with proper firearms."

Ericsson was so intensely absorbed in his study of the means best adapted for the defence of Sweden's threatened nationality, that he could not comprehend the indifference with which his opinions were received in some quarters. "I consider it an insult," he wrote, "that the principal papers at the capital do not all of them publish my report, for the editors

are not blockheads and must therefore know that they cannot present to their readers anything more interesting just at present, when the defence of the country upon the sea attracts the attention of the entire nation. I expected encouragement from my fatherland, as it is for its welfare I am now working and spending large sums. I cannot deny that the neglectful silence of the Swedish press at this time has affected and, in a measure, checked the unbounded enthusiasm with which I have so long labored for the naval defence of my fatherland, convinced that if it is not strong our fight against Russia and Germany will be vain."

Speaking of his intention to reply to "lying allegations" concerning his work appearing in a Swedish paper, Ericsson said: "Not that I care on personal grounds, but because these allegations will, if uncontradicted, to some extent, impair my standing in Sweden, and thereby affect my ability to be useful to my countrymen." His reply assumed the shape of an address "To my Countrymen." It was a vigorous defence of his gunboat scheme against the assaults of an anonymous newspaper correspondent.

This letter was a contribution to an active controversy in Sweden, the old time professional prejudices being arrayed against Ericsson there as well as elsewhere. "May this controversy cease," exclaimed Ericsson, in the peroration to his address, "but not until with 'our weapons' for cases of necessity, our energy, and our high intelligence we have shown the world that we have power not only to resist but to defeat the enemy who threatens our independence." The appearance of this letter did not altogether please Ericsson's cooler-headed brother. He argued, very sensibly, that it could lead to no result, except to flatter the critics, and the paper inviting their contributions, by the attention shown them, and thus provoke them to new efforts of hostility. "You gain nothing," wrote Nils, "by thus descending to the level of these champions of the old style man-of-war. They cannot be convinced, and to silence them is impossible." But when was an enthusiastic inventor ever silenced by such reasoning? And, no doubt, controversy had its charm for one who wrote with such facility, and was able to express his thoughts with such clearness and force.

Ericsson designed a light steel gun to be carried between two cavalry horses, and used by a force acting independently. He intended such guns primarily for the defence of Sweden, and intended to send some of them at his own expense; they would, he wrote November 6, 1868, "long ere this have been on Swedish soil if his Majesty had not wholly mistaken their object. As an auxiliary to infantry, this weapon is worthless; but arm a regiment or two with it to act independently, and you could crush any invading force whatever, cavalry, infantry, or artillery." One of these guns was sent to West Point for experiment. It was especially designed for such service as that performed by cavalry troops during the Civil War, when they so successfully combined the functions of cavalry and infantry, and enlarged the rôle of the horseman in war.

In September, 1868, the authority of Queen Isabella II. was overthrown, and Spain was for a series of years distracted with civil strife. The discontented Cubans seized this opportunity to rebel, and the Provincial Government, representing Spanish authority, occupied as it was with contentions at home, found great difficulty in dealing with this new element of disorder. In January, 1869, 1,500 troops were sent from Spain to reinforce the Cuban garrison. A thousand more followed in February, and 2,200 in March, and before the war was over the number approached 100,000. The Spaniards, aided by the local volunteers, were found unequal to the task of controlling the island. Sympathy with the insurgents was universal throughout South America, and there was a strong public opinion in the United States favoring the overthrow of Spanish authority in the Antilles. This found expression in expeditions sent out from the United States, carrying men and supplies to Cuba. A decree was issued threatening with penalties of piracy vessels conveying aid to the insurgents and carrying an unrecognized flag. But it was *brutum fulmen*, as Spain possessed no adequate means of protecting herself at sea.

In this extremity a sum of money was placed at the disposal of the Cuban authorities to procure additional men-of-war. Captain Raphael de Aragon, of the Spanish Navy, was sent by Admiral Malcampo, Naval Commander in Cuba, to the United States early in 1869, to secure the vessels needed. Va-

rious suggestions were made to him. One ship-builder proposed to expend the entire amount at his disposal upon a single craft; another proposed two, but neither presented a satisfactory plan. Messrs. Delamater & Co. were called upon. They consulted with Ericsson. As he had just dealt with a similar problem in studying the defence of Sweden, he was able at once to suggest a definite and intelligent scheme. He agreed to furnish the working plans for thirty gunboats on two conditions: first, that these plans were not to be called for until the work was ready to be put in hand; and next, that the contract should be given to his friend Delamater. When the Spanish authorities demurred to this first condition, it was explained that Captain Ericsson had never presented to the American Government any detailed plans of the numerous vessels he had constructed, the Navy Department having in every instance trusted to his great experience and skill in constructing war vessels. General dimensions of hull and machinery, with a brief specification setting forth other principal features of the structures, formed the basis of contracts with the United States.

With so distinguished a precedent to guide them, the Spaniards wisely decided to leave the matter to the individual judgment of the man who of all men best understood it. They contented themselves with stating the object they had in view. Ericsson's plan was to form around Cuba a cordon of light vessels, each armed with a 100-pound gun, with engines of 160 horse-power, giving ten knots maximum speed in smooth water, carrying coal for six days' moderate steaming, and having a storage capacity for water and provisions for thirty days. It was expected to secure this in a vessel of 22 feet beam 100 feet in length, and with 8 feet depth of hold. It was found necessary to increase the length to 107 feet on the water-line and 22½ feet beam. To keep within the requirement of a draught not exceeding 59 inches (1½ metre) the keel was omitted. Two propellers were provided, of unusual size in proportion to the hull, and the vessel was schooner-rigged with a moderate amount of sail-power. Ericsson's favorite idea of fighting bows on was illustrated here, and the 100-pound improved Parrott gun was trained to fire over the bow and in a line with the keel. The bulwarks forward were set on hinges

so that they could be lowered, and the gun fired *en barbette* with a range of 120 degrees on each side of the bow, or 240 degrees in all.

Captain Ericsson's purpose was to show how a gunboat for coast defence might be reduced in size by good planning, and the steam machinery gives another illustration of his ingenuity in devising expedients to meet novel conditions. His surface condensers were made to do double duty, not only returning the steam to the boiler in the shape of fresh water, but serving also as a support for the engines, thus dispensing entirely with the usual frame-work. This made it possible to meet the objection that twin screws, with their duplication of working parts, produced too much complication and weight for small vessels. These double screws were as compact as ordinary single-screw engines of equal power. The bearings were made self-adjusting by peculiarities of construction. The reversing gear was so arranged as to give the officer on the deck complete control of his vessel, enabling him to start, back, or stop either propeller without the assistance of the engineer.

The price for each vessel was $42,500, and this whole fleet of gunboats cost but little more than a million and a quarter of dollars, or no more than a single cruiser of moderate size. The contract was signed by the Delamater Iron Works, New York, May 3, 1869; the first keel was laid May 19th, and the first vessel launched June 23d, thirty-four working days after laying the keel. In three months and sixteen days from this time the last vessel of the thirty was launched, and fifteen of the fleet had engines and boilers on board.

When the fleet was ready for sea, and the saucy-looking craft lay ten abreast off the Delamater Works in the Hudson River, a United States marshal appeared with orders to seize them for violating the neutrality laws. It was alleged that they were fitting out for an assault upon Peru, Spain having recently been at war with that country, and having still an unsettled account with her. Affidavits presented by the designer and the builders of the thirty gunboats made it clear that they were intended only for home defence, and could not be used for aggression, as unless they could touch land at short intervals to

secure supplies, their offensive as well as their defensive power would cease.

Before this difficulty was settled, another arose. The Act of March 3, 1817, "more effectually to preserve the neutral relations of the United States," forbade the "fitting out or arming of any ship or vessel, with intent that such ship or vessel shall be employed in the service of any foreign prince or state, or of any colony, district, or people, to cruise or commit hostilities against the subjects, citizens, or property of any foreign prince or state, or of any colony, district, or people with whom the United States are at peace," etc. The counsel for the Cuban Junta in New York, Mr. Grosvenor P. Lowrey, presented to the United States District Attorney an argument to show that the Cuban insurgents were such a "colony, district, or people," and asked that the gunboats be libelled. He also proceeded to Washington, accompanied by Mr. Wm. M. Evarts as associate counsel, and there renewed his argument before the Attorney-General and before President Grant, whose sympathies, and still more those of the Secretary of War, General Rawlins, were with the Cubans. A debate on this question also arose in Congress, Senator Matthew H. Carpenter, of Wisconsin, presenting the argument of the Cubans, and Senator Charles Sumner, of Massachusetts, Chairman of the Committee on Foreign Affairs, contending that Cuba had no legal existence, her belligerency not being an accomplished fact and the contest merely one with guerilla bands.

It was finally decided that Spain was not making war on an independent people, but simply maintaining authority within her own borders. This decision was a great relief to Ericsson as well as to Delamater, as the law not only provided for the seizure of the vessels, but for the punishment by fine and imprisonment of all guilty of the "high misdemeanor" of participating in fitting out an illegal expedition.

The first vessel on her trial fell four one-hundredths of a knot short of her contract speed, but Ericsson showed that the extra speed might have been obtained by "improper expedients" customary in such cases, such as carrying the smoke-stack to the usual height, instead of shortening it fifteen feet, as he had done to keep it out of the way of the sails. "I cannot," he

said to Mr. Delamater, "dismiss the subject without reminding you of the strong objections I urged from the beginning, against high speed, as not compatible with that class of vessels best suited for coast defence, viz., a small, light-draught, handy, and economical gunboat which can, on extraordinary occasions, for a short time, run at the rate of eleven English miles an hour. Let me add, anything above that speed calls for sacrifices fatal to practical utility; and after all, if provided with disproportionate engine-power, such a craft cannot carry fuel for any distance, and hence will spend its time at the coaling stations, in place of watching and defending the coast. Having exhausted all mechanical resources, and brought to bear on the construction of the Spanish gunboats the experience of a long professional career, I cannot allow myself to think that the result of my labors will not be cheerfully accepted by Admiral Malcampo and his Government."

The vessels were accepted, and they proved so satisfactory to the Spanish Government that they found no reason to regret the unusual confidence leading them to entrust the building of a fleet to an uncommissioned civilian, without undertaking in any way to direct his work. Captain-General de Rodas was able to issue another proclamation to the insurgent Cubans on March 24, 1870, reminding them that in view of the thirty war vessels appearing like magic on their coasts, they could no longer depend upon support from abroad. "From day to day," he said, "there will be no place or hour secure for you; the gunboats are on the coast to which you turn your gaze."

Thus for a second time did rebellion on the western shores of the Atlantic receive a staggering blow from the hand of John Ericsson, though many Americans may regret that he had not stayed his hand in this instance. There can be little doubt that if he had withheld assistance from the Spanish authorities, the Cubans would have achieved their independence.

Receiving at this time a letter from John Laird, M.P., the eminent ship-builder of Birkenhead, England, concerning the performance of the unfortunate *Captain* under sail, Ericsson in reply expressed his surprise at the result reported. Speaking of his experience with twin screws, he said to Mr. Laird:

"I recently planned a fleet of thirty twin-screw gunboats for Spain, in which case, apart from adopting the most favorable lines in the run, I introduced every possible refinement, such as extremely thin blades (bronze), a perfectly true screw, spherical exterior to the shaft, bearings to keep the same fair with the shafts, self-adjusting thrust-bearings, etc.; yet these vessels do not work under canvas as they ought. Fortunately, the Spaniards think otherwise, and are so well pleased that they have sent me a commander's cross of the Order of Isabel la Catolica."

Admiral José Malcampo, in the letter dated Havana, April 7, 1870, accompanying the decoration, said: "I deem it my duty to say to you most earnestly that, although I am aware that the decoration does not by any means reward the eminent services rendered by you to my country, nor your kind intentions, or the skill displayed as regards the difficult problem of constructing the gunboats, and the mounting for the artillery procured in the United States; yet I have great pleasure in congratulating you personally on the distinction you have received, and in tendering you at the same time the testimony of my sincere regard."

In reply Ericsson said: "I have the honor to acknowledge the receipt of your letters of April 4th and 7th; the former presented to me by Captain Rafael de Aragon.

"I beg to assure you that I duly appreciate the very kind manner in which you have been pleased to express your satisfaction with my labors relating to the Spanish gunboats. I will preserve your flattering letters with greater care than any treasure I possess.

"With reference to the distinguished honor which, through your recommendation, your Government has bestowed upon me, I only fear that I have not done enough to merit such a mark of approbation from the great Spanish nation. I can only hope that some other opportunity will present itself which will enable me to furnish some substantial proof of my gratitude for so great an honor as that of wearing the commander's cross of the ancient and high order of Isabel la Catolica.

"I avail myself of the present opportunity to express to you my admiration of the distinguished representative of the

Spanish Navy, Captain Rafael de Aragon, to whose energy and skill you are mainly indebted for having, in the unprecedentedly short time of eight months, procured a fleet of thirty vessels of war. I can say with perfect sincerity that, during my forty years of intimate acquaintance with naval officers of the leading maritime nations of our time, I have not met anyone who so thoroughly understands his profession as my friend—I feel proud to regard him so—Captain Rafael de Aragon. The Spanish Navy is to be congratulated for possessing such an officer, while the Spanish nation is fortunate in having placed its Cuban Navy in the hands of a commander whose accurate appreciation of the abilities of his subordinate officers enabled him to select the proper man for the important trust of superintending the construction of the thirty gunboats." *

In 1886 Ericsson presented to King Alfonso, through Captain del Arboe, Chief of a Spanish Naval Commission, finished drawings in detail of the *Destroyer* system, and his submarine artillery. The King gave orders to notify Ericsson at once by telegraph that his system would receive the royal support. A diploma conferring upon him the Grand Cross of the Royal Spanish Order of Naval Merit was also sent through the Spanish Minister at Washington.

* Of the thirty gunboats built for Spain in 1869, eleven were in 1889 still on the Spanish naval list of "Canonnières à Hélice de 4me classe," viz., *Alemendares*, *Cauto*, *Contramaestre*, *Criollo*, *Descubridor*, *Ericsson*, *Flecha*, *Gacela*, *Guardián*, *Indio*, and *Telegrama*. The gun-carriages applied to these vessels were so satisfactory that the Spaniards ordered similar ones for other vessels. One of these was on the Spanish gunboat *Tornado*, when, in 1873, she nearly involved the United States in a war with Spain by running down and capturing the *Virginius*, having on board men and material for "Cuban patriots."

CHAPTER XXVII.

BUILDING AND MOUNTING HEAVY GUNS.

Improvements in Heavy Guns.—The Oregon and the Horsefall Guns.—Advanced Ideas on the Subject of Heavy Ordnance.—Remonstrance against the Guns of the *Monitor*.—Contract to Build a 13-inch Gun.—Its Trial by the Government.—Ericsson Prophesies Failure of England's Armstrong Gun.—Gun-carriages.—Victor Hugo's Story of the Corvette *Claymore*.—Ericsson's Compression Gun-carriage.

IN connection with his labors upon vessels of war, Ericsson devoted no little ingenuity to the improvement of heavy guns, his efforts in this field being directed by a most exhaustive study into the strength of materials, the operation of explosive forces, and the laws governing the flight of projectiles. After his investigations began, steel took the place of iron, great improvements were made in powders, and the study of high explosives, in their application to war, was vigorously prosecuted. Yet none of these changes carried him beyond the principles established for his guidance as early as the year 1842, when he bound the cracked *Princeton* gun with hoops. In a private letter he says:

The first of the *Princeton* guns, the "Oregon" 12-inch bore, cracked under a charge of fifty-six pounds of powder, from the simple reason that it was not permitted to recoil during the proof, its breech being firmly imbedded in the slope of a sand-hill. The crack extended nearly from the trunnion to the chamber, notwithstanding which I at once applied hoops of a peculiar construction, and succeeded in making the gun strong and reliable. Experimental firing was carried on with this piece for some time at Sandy Hook, and ultimately, at the Philadelphia Navy Yard, it was subjected to a test of 150 rounds with battery charge without giving way. These extraordinary facts attach an interest and importance to the "Oregon" greater probably than to any piece of ordnance ever made. Yet reports concerning this gun simply state that the "Oregon cracked," leaving the impression that the gun was ren-

dered useless. . . . I would observe that the gun which burst on board the *Princeton* under a charge of only twenty-five pounds, had been previously destroyed by a hollow shot too large for the bore, and forced home with great effort. This hollow shot, which had stuck during the discharge, came out in small fragments. By this unfortunate occurrence the gun was fatally ruptured.*

In a letter to the Naval Chief of Ordnance at Washington, November 23, 1864, he further said: "Guns made on the plan of the great Horsefall gun, welding voussoir (**V**-shaped) bars upon a case made of a fagot of square bars, are very unreliable. It is impossible to insure a sound weld through all the radial joints of a pile laid upon that system. Each blow of the hammer, especially after the pile has become reduced in temperature below welding-heat, tends to separate the bars, those under the hammer acting like wedges. The second Stockton gun was made in nearly the same manner as the Horsefall gun. It will be remembered that it split through the centre under a very moderate charge, on board the United States steamer *Princeton*."

The Horsefall gun was a smooth-bore wrought-iron gun with a calibre of 13.014 inches, built in 1856 by the Mersey Steel and Iron Company, England, and tested with a maximum charge of 80 pounds of powder and a 282-pound shot. It showed an initial velocity of 1,631 feet with a 74.4 pound charge.

When, in 1887, the son of Rear-admiral Dahlgren asked approval of a statement he had prepared, showing that his father's gun had revolutionized the navies of the world, Ericsson called his attention to the fact that his own gun had, in 1842, penetrated four and one-half inches of iron and passed through a sand-bank behind it eight feet thick. "How far," he said, "this result, in connection with the perfect success of my new wrought-iron carriage tested on board United States

* In a letter to the author of this biography, dated September 19, 1890, Commodore William M. Folger, Chief of the Naval Bureau of Ordnance says: "The records of the guns in this office show that the gun which replaced the 12-inch which burst on the *Princeton*, is now at the New York Navy Yard and that the 12-inch gun called the 'Oregon,' is now at the Naval Academy, having been sent there in July, 1867. They are both among the relics and are preserved for their history."

ship *Princeton*, 1843, dispensing as it did with breeching, revolutionized naval artillery, the records in the archives of the maritime countries of Europe furnish decisive information."

The first guns used on the introduction of artillery were made of longitudinal bars of wrought iron, arranged in a circle and surrounded by hoops. Small guns were used or large guns with moderate charges. As the demands upon ordnance increased, cast iron was substituted, as the ease of handling was supposed to compensate for its inferior tenacity. It is an uncertain material, but the Dahlgren 11-inch guns, and the 68-pounders used in the Crimea, have a record of over 2,000 rounds, and several of the siege guns—24-pounders—used at St. Sebastian in 1813, are stated to have fired 6,000 rounds.* The superiority of American cast iron was so great as to equalize in a large measure, in smooth-bore guns, the advantages claimed for the wrought-iron guns manufactured abroad, until steel was universally adopted for heavy guns.

A French officer named Thierry, in 1834 and 1840, made guns of cast iron hooped with wrought iron, and an English patent for this device was granted in 1848 to one Frith. Ericsson, who never believed in cast iron, sought to accomplish the same purpose in a wrought-iron gun by surrounding the core with washers, or perforated disks of thin plate-iron, set in close contact. In welding so large a mass as the body of a gun, the tendency is to destroy its fibrous character, and the intermittent strains of explosive shot subject it to alteration of texture. As the fibrous character of the iron was retained in the rings, their tensile strength was estimated to be double that of the body of the gun, and rings could be applied of sufficient width to prevent the gun from splitting, if filled with powder from end to end. Such fibrous metal will bear a vibration from explosive charges, far in excess of that required to break a bar of crystalline iron of much greater apparent tensile strength.

A proposition to furnish a gun built upon Ericsson's plan was made at the time the original *Monitor* was built. "Dahlgren," Ericsson says, "opposed my proposition to employ very heavy ordnance, and protested over and over again during the manufacture of the 15-inch guns, that he had 'nothing to do with

* Holley: Ordnance and Armor, p. 312.

the project,' and that he 'simply carried out instructions.' Dahlgren & Co. opposed my 12-inch gun of 1841, as being too large for practical utility, but afterward assisted in producing the 10-inch gun for firing solid shot; and many years after he ventured on the 11-inch *shell* gun which was put into the *Monitor* turret to throw *solid* shot, under strict orders not to exceed fifteen-pound charges.

"I protested against so light a charge when I took the contract to build the *Monitor*, and offered myself to supply 12-inch guns capable of bearing heavy charges; but my offer was not accepted, and my remonstrance against the light 11-inch gun was in vain. Practice soon proved that heavy guns were indispensable; but the claims of the person who had first urged heavy ordnance, and who had built already in 1841 the 12-inch gun for solid shot, were forgotten; while the constructor of the 11-inch shell gun and opponent of heavier ordnance figured alone as the creator of a new system, *after* the practical success of the 15-inch gun."

In 1854 the 11-inch gun was considered too heavy to be allowed in the Navy, and was not admitted into use until just before the outbreak of the Civil War, in 1861. Then the Ordnance officers were so afraid of it that they would allow but fifteen pounds of powder in a gun equal to the strain of fifty pounds. Ericsson's knowledge of the strength of material showed him its capabilities, but he could convince no one else. The 11-inch gun weighed sixteen thousand pounds; the 15-inch gun that followed it, forty-two thousand pounds. Now, guns weighing one hundred and ten and one hundred and eleven tons, or five times as much as the American 15-inch gun, are in the service of foreign navies. No 15-inch gun burst in our naval service during the war, though the charges recommended by Ericsson at the outset were finally adopted. A trial gun, tested with charges varying from thirty-five to seventy-five pounds of powder, burst at the eight hundred and sixty-eighth round, and three guns had their muzzles broken off by the premature explosion of shells, one at Charleston and two at Fort Fisher.

The 15-inch cast-iron gun was tested with charges up to one hundred pounds of powder without showing any enlargement of the bore, and an attempt made to burst it in England, on

the Shoeburyness proving-ground, by firing it at the trying elevation of forty-five degrees with this maximum charge, resulted in the discomfiture of the British artillerists, whose purpose was to discredit American ordnance.

On April 24, 1863, the Navy Department accepted an offer from Ericsson to build 13-inch wrought-iron guns at sixty-four cents a pound, or about $30,000 each. One of these was to be furnished by him and his associates for trial, and orders for others were to follow if the trial gun stood the test. As the first gun cost them over one dollar a pound, a loss of nearly $20,000 was the result. The gun was tested in November, 1864, with charges ranging from thirty to sixty pounds, the elevation gradually rising, as the charge increased, from fifteen to twenty-seven degrees. At the nineteenth shot the trunnion band burst and remained separated about two inches. A number of cracks had also opened, the largest being two feet long and wide enough to admit the point of a knife from one-quarter to one inch deep.*

The gun was too short, the centre-block was not a good forging, and the quality of the material, although the best in the country, was not favorable to welding. Still, Ericsson believed that the trial was an unfair one. As high elevations were not required for naval guns, he had designed his for a maximum elevation of nine degrees. Describing the trial of this 13-inch gun in a letter to his familiar friend, Captain Adlersparre, February 8, 1865, he said:

> The elevation was carried up to thirty-five degrees, and "*quick burning*" cannon powder, such as Rodman would not venture to put into his 20-inch gun, was used. To show my confidence in the strength of the gun I directed the shot to be wrapped with cloth, stopping the windage entirely. The great elevation, however, was agreed to under protest. I informed the Ordnance Bureau that, as the piece was made exclusively for the moderate elevations peculiar to the turret, the trunnion band was not strong enough to sustain it at thirty-five degrees elevation for continued firing. The trial, however, was successfully concluded, and the unexpected result obtained produced a profound sensation among the Ordnance officers. No one else knew anything about the matter, as the trials were all conducted in secret. It was found, on

* Report of Guert Gansevort, Inspector of Ordnance, to Chief of Bureau of Ordnance, November 30, 1864.

revising the measurements, that the range was nearly six miles. A solid 13-shot being hurled such a distance, all admitted to be an achievement without a precedent.

But I need hardly say the powerful cast-iron interest became greatly excited. Certain imperfections in the bore, common to all wrought guns, were pointed out, and a second test was demanded to which I readily acceded, having no fears excepting that the strain on the trunnion band, with such great elevations, might prove injurious. On the nineteenth round of this second trial the trunnion band parted under the gun, at a point where we had from the beginning observed signs of an imperfect weld. Having removed the fractured band, we put the gun into the lathe, and to my delight found that it turned as true on its centres as if it never had been fired. The external form has not changed as much as the thickness of a hair in any direction! A new trunnion band is now being applied. In the meantime, those who know most on the subject claim that this is, beyond all comparison, the most powerful and reliable gun in the world.

The injury to the trunnion band was not a serious matter, as a new band could be applied, and this was done. Nor were the cracks in the bore more serious in Ericsson's opinion. He showed how this defect could be remedied by inserting a steel lining, but the Bureau insisted that this should be done at his expense. As this would increase the loss he had already incurred, he protested against "the assumption that an experiment intimately connected with the efficiency of the iron-clad navy ought to be made at the expense of an individual." In a private letter to Captain Fox, December 29, 1865, he said:

You have a 13-inch gun now at the Brooklyn Navy Yard that may be safely fired with one hundred pounds; but unfortunately your Ordnance officers do not understand the value of what they have got. It is difficult for me to restrain my feelings whenever I allude to this subject, and I hardly venture to call to mind the decision of the Bureau, that a steel lining ought to have been put in at my expense. Had the new process of making steel in large masses been introduced into this country, as we expected, a gun, similar to the neglected 13-inch plate one, but with a steel core, would have been made long ago.

On this subject I will only further observe that, if the Treasury could only raise one million of dollars, that million ought to be spent on naval ordnance capable of burning from one hundred and twenty to one hundred and sixty pound charges. Such guns, if made of steel and hooped precisely as the gun now in the Navy Yard, would weigh only one-half

of the Rodman, and fire five hundred pound solid spherical shot, which with the stated charges would beat Armstrong two to one.

Knowing that your Ordnance officers do not understand the hooped gun, I have thought your plan of putting the 20-inch guns into the *Puritan* turret most excellent, and the only one that could at present be adopted. The day will come, however, when your Ordnance officers will be more severely criticised for refusing my hooped gun than the British admirals who refused my propeller. Far more may be said in excuse of the latter than the former. I feel strong enough to fight another twenty years, and therefore quite sure to gain as signal a triumph over your present Ordnance men as over the English admirals a quarter of a century ago.

Ericsson's gun was an experimental one, and he was conscious of its imperfections, yet, as he said in a letter to Captain Wise, the Naval Chief of Ordnance, "this gun, with its imperfections and its hoops, is safer probably than any cast-iron gun ever made. I have stated before, and I now repeat, that these imperfections were not looked for and they are decidedly objectionable; but I cannot admit that the mode adopted by the Bridgewater Works in forging the gun is improper. It may be shown that the plan of welding together slabs will give the greatest strength to the general mass, though small imperfections in the centre of the block cannot be prevented; but these, as I have before stated, may be rendered harmless if the bore be lined with plate iron or soft steel plate."

As it required upward of fifteen tons pressure to force each of his two hundred hoops or washers over his gun, Ericsson estimated that "these hoops, in virtue of their inertia and the recoil of the core, opposed to any disturbing force in the longitudinal direction a resistance twenty times as great as that force." The opinion he entertained from the beginning, that the Armstrong plan was certain to fail, was due to his knowledge of the fact that the heat required for this system of gun construction utterly destroyed the fibrous nature of the metal, and that, aside from this, it was impossible to insure a sound weld in every part. The welds were perpendicular to the bore, and, as an imperfect welding weakened a gun in the direction of its length, the hoops designed to strengthen it in this direction of its circumference were useless.

After spending many millions in experimenting with this

gun, the English artillerists finally learned the lesson Ericsson would have taught them as the result of his experience long before. In spite of his warning, they insisted on depleting the public purse with target exhibitions, chiefly remarkable because the guns used came directly from the rolling-mill, and after a few rounds were consigned to the scrap-heap, because of flaws and imperfections inseparable from the system. Using the *Army and Navy Journal* as his medium of expression, Ericsson continued to unsparingly ridicule British neglect of American precedents, and warn others of the certain result; but Ephraim was "joined to his idols," and neither argument nor sarcasm was availing.

"The Government of the United States," said Ericsson, in a letter written in 1866, "seriously entertains the idea of casting 25-inch guns to throw shot of a ton weight for the Navy. It can and will be done. Guns of 20-inch calibre of wrought iron the writer will some day make, and here the increasing the size of guns will be ended, as increasing the size of ships ended with the *Great Eastern*." At an earlier date, May 19, 1862, he had said: "Whatever the size may be, there let us stop, and then go for the greatest possible initial velocity. The proposed 16-inch shot will in my opinion be found very near the true size for producing maximum effect."

A few 20-inch guns were made by the United States, but with them effort in that direction ceased. Steel has taken the place of iron for gun construction; loading at the breech has been substituted for the clumsy muzzle loading; guns have been lengthened; much study has been successfully devoted to the improvement of powder and projectiles, and muzzle velocities of over 2,000 feet per second have succeeded to those of 1,600 feet.

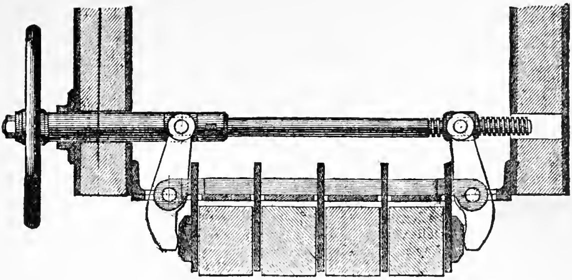
The early argument against heavy navy guns was the supposed impossibility of handling them on board a ship. The question of their success or failure in naval warfare was, therefore, involved in the question of gun-carriages. Even the small guns used on board of men-of-war gave great trouble when the only means of controlling them was by use of rope shackled to the ship's ribs, and passed through a hole in the knob-like projection on the breech of the gun called the "cascabel."

A chapter in Victor Hugo's story of "Ninety-three" is de-

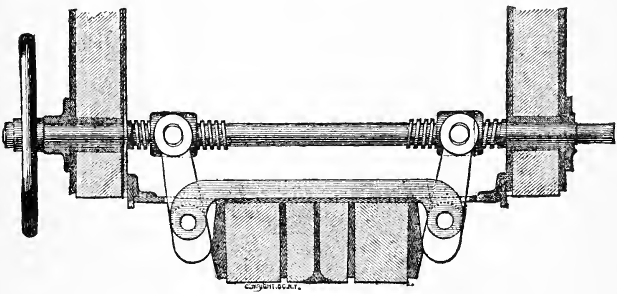
voted to the performances of a 24-pound carronade that breaks its mooring on the royalist corvette *Claymore*, and "becomes suddenly some supernatural beast; a monstrous mechanism for wrecking a ship; cracking the masts; multiplying breaches in the sides until the vessel begins to take water; disabling the other guns of the battery; crushing four men at a blow, and cutting a fifth in two. You can make a mastiff hear reason, astound a bull, fascinate a boa, frighten a tiger, soften a lion; but there is no resource with that monster, a cannon let loose. You cannot kill it, it is dead; at the same time it lives. It lives with a sinister life bestowed upon it by Infinity. It is moved by the ship, which is moved by the sea, which is moved by the wind; hence its frightful vitality. How to assail this fury of complication? How to fetter this monstrous mechanism for wrecking a ship?" This, the question Hugo asks, Ericsson set himself to answer more than a quarter of a century before the great Frenchman revived his reminiscence of an earlier time to furnish material for one of the most dramatic descriptions in all his writings.

We have seen how Ericsson dealt with this problem in handling his 12-inch gun upon the *Princeton*. The principle of control once established, he found no difficulty in extending its application to the much heavier 15-inch guns mounted in the turrets of the monitors.

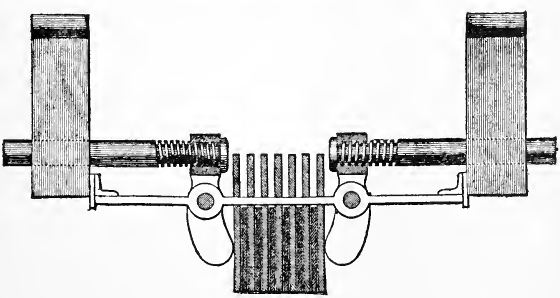
The army gun-carriage in ordinary use was one developed by a gradual process of evolution, from the timber block or frame, to which the first cannon was secured by straps or bolts. The carriages used for mounting the guns of a naval vessel in broadside, when Ericsson brought his ordnance novelties with him to the United States in 1839, were modifications of the army carriages used in the casemates of forts. They were mounted upon wheeled trucks and controlled by tackles, hooked to the side of the ship on the right and left of the gun. These tackles were used to move the gun from side to side, and there was besides a "train tackle" hooked to a ring bolt behind the carriage. The recoil was controlled by the breeching. For this clumsy and most unsafe contrivance, as Victor Hugo's description shows it to be, Ericsson substituted the carriage illustrated here.



1. Section Showing the Friction-gear Applied to the Princeton, 1842, and to the Gun-carriages of the United States Iron-clad Fleet, 1862–67.



2. Section Showing Captain Scott's Plagiarism.



3. Section Showing Sir William Armstrong's Plagiarism.

The friction-gear for controlling the recoil is also shown, with two examples of plagiarism. This use of his ideas without credit greatly annoyed Ericsson, as it put him in the position of being himself the copyist. In a letter to Bourne, dated May 11, 1866, he said, in replying to someone's claim of priority for his invention :

The motive-power at hand being small, and the work to be performed being large, a proportionate lapse of time seemed inevitable. At last I examined the *condition of success*, a method by which I have often triumphed over seeming mechanical impossibilities. *That* condition in this case was a compressor or friction apparatus *remaining always under pressure*, capable of being attached to, or detached from, the gun-carriage by some catch or lock. From obvious reasons, the ordinary sliding compressor cannot, by any mechanical expedient whatever, be kept under *continuous* pressure. The idea therefore suggested itself of making a rotary compressor. On reflection, the adoption of *rotary friction* is not incompatible with the condition of *not being relaxed while the gun is being rolled out*, since the instrument by which it is produced may be alternately attached to the carriage or detached from it. With this brief introduction I now refer you to the enclosed drawing and description.

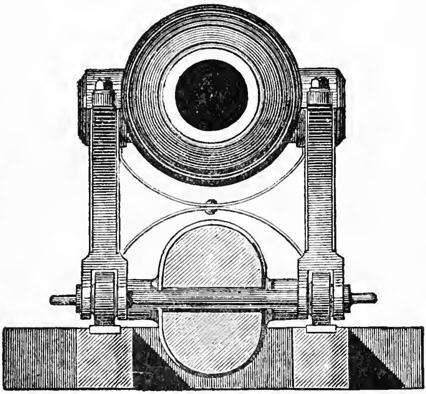
Fortunately, the invention was perfected in time to be applied and tested on board of the *Dictator*, by the talented Commodore John Rodgers, who has reported to the Navy Department that the success is complete, and that not a second is lost in applying or relaxing the necessary friction. As soon as the gun has been loaded the gunner lifts the check lever, and the instant the gun has been rolled out he drops it. . . . The most remarkable feature of the trials is the very slight tension applied to the set screws by which the friction disks are brought in contact. It has been found that for 55-pound charges of powder a force of ten pounds, applied at the end of a wrench twenty inches long, is sufficient to tighten the set nuts. As a consequence of this light pressure, no heat is produced and no abrasion takes place between the friction disks.

It may be asserted that this apparently trifling invention renders the *Dictator* the most formidable fighting ship in existence, since it enables her guns to be worked with perfect safety in any weather. It has been observed by many that the rotary compressor is a mechanical paradox, since in effect neither time nor force is required to produce or relieve friction of the greatest possible intensity. . . . By means of this training-gear, a 15-inch gun may be as safely handled in broadside as in a turret. The question is simply one of proportion and strength of parts, which every well-informed engineer can determine.

As the British iron-clad navy is composed solely of broadside ves-

sels, this gun-carriage is of such paramount importance, and so intimately connected with the system, that I could not withhold the model.

In the *Princeton* gun-carriage the iron plates were pressed against the timbers by a cam. In the *Monitor* carriage a screw was substituted for the transverse axle and its cam, but, as the operation of the screw was slow compared with the almost instantaneous action of the cam, Ericsson subsequently returned to his original idea. He gives a full account of his invention



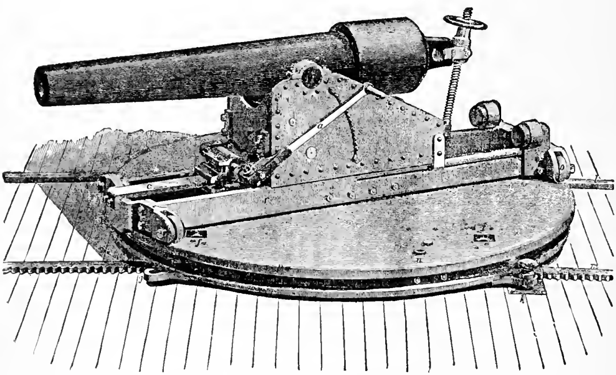
Muzzle View of 12-inch Princeton Gun, Showing Friction-gear of Carriage.

in another characteristic letter to Bourne. Speaking of the slow fire of the *Monitor* guns, and explaining that it was due to the time occupied in tightening and loosening the compressor designed to check the recoil, he says:

It was John Ericsson who first dispensed with breeching for checking the recoil of naval ordnance. In 1842 he introduced wrought-iron carriages composed of plate iron, precisely like the *Monitor* carriages, for the 12-inch guns of the *Princeton*, with longitudinal timbers attached to the slides under the carriage, which timbers were pinched between iron plates for the purpose of checking the recoil of the piece. So completely did the plan answer that the recoil of the 12-inch gun fired with thirty-pound charges was checked in a distance of sixteen

inches. No trouble whatever was experienced with the compressors thus introduced. The invention proved a perfect success from the start. It will be seen, therefore, that Mr. Mallet must go further back than 1856 to establish his claim to be the original inventor of compressors for preventing the recoil of guns.

Accompanying this letter was a model of which the inventor said: "It is intended as a present to the Emperor of the French, who has acted ungenerously toward the writer, and thereby engendered a desire to shame his Majesty."



Rotary Gun-carriage and Transit Platform Applied to the Spanish Gunboat Tornado, 1873.

On December 19, 1865, Captain Fox wrote to Ericsson, stating that the naval gun-carriage could not be used in a seaway, was very clumsy, defective mechanically, and altogether unsatisfactory. He asked Ericsson to provide an iron pivot-carriage. This was furnished, and nearly five years later, June 11, 1870, Commander Edward Simpson, U. S. Navy, reported that he had tried the Ericsson carriage, and found it capable of enduring the most severe tests under fire. The compressor gear—consisting of a cam moved by a lever as on the *Princeton*—was found fully competent to stop the movement of the gun at any point when it was in motion, its action being complete and instantaneous, and quite as effective as that of the carriage

requiring a slow-moving screw to tighten the compressor. The cut on the opposite page shows a pivot-carriage of this description placed on the Spanish gunboat *Tornado* in 1873.

May 1, 1876, Commodore William N. Jeffers, Chief of the Bureau of Ordnance, made a request similar to that of Captain Fox, saying "that he had devised a carriage which did not altogether please him, and he did not like the hydraulic buffer system, and preferred Ericsson's method of using friction. November 22d following he wrote, saying:

"When I returned from New York I informed the officers at the Washington Navy Yard that I was so well satisfied with your carriage that I should make no more of the regulation one, and that, if they could not devise one as good or better than yours, their occupation was gone. This stirred them up, and they now have a design which I propose building for the third carriage, mounting yours side by side, and theirs aft."

CHAPTER XXVIII.

THE ART OF WAR IN ITS INFANCY.

Neutralization of the Ocean Proposed.—Beneficial Results of the Professional Study of War.—Subaquatic Attack.—The Rôle of the Heavy Armored Vessel Ended.—Locomotive Torpedoes.—The Amphibic Projectile.

IN 1810, Robert Fulton, "Fellow of the American Philosophical Society, and of the United States Military and Philosophical Society," as he styled himself, published at New York a pamphlet on "Torpedo War and Submarine Explosions." The title-page bore this significant motto:

"The liberty of the seas will be the happiness of the earth."

What is here indefinitely suggested by Fulton we find declared by Ericsson in distinct terms. In explaining a proposition he made in 1870 to demonstrate the efficiency of his method of under-water attack by sinking, with his submarine projectiles, a vessel while it was being towed by at any practical rate of speed, he said: "My only object is that of seeing the sea declared by all nations as sacred neutral ground. It is the highway of mankind." * Again he said: "The art of war, as I have always contended, is positively in its infancy. When perfected, man will be forced to live in peace with man. This glorious result, which has been the cherished dream of my life, will unquestionably be attained before the close of the present century." †

Only ten years of the century remain, and no doubt this forecast as to the neutralization of the ocean will prove to have been too sanguine; yet, certainly no one familiar with the sub-

* Letter to G. V. Fox, May 12, 1870.

† Letter to John Bourne, December 21, 1866.

ject can fail to be struck with this prophecy as to the future development of the art of war. It is a quarter of a century since it was recorded, and within that period what enormous changes have taken place! Powders have been improved, and the use of high explosives has added another element of horror to warfare. New factors have been introduced, and the power of the old enormously extended. War vessels have increased their thickness of armor four- and five-fold, in the vain hope of excluding projectiles fired from guns whose power has been developed in still greater ratio; while enemies hidden beneath the sea assail the cumbersome armor-clads where they are without defence.

Concerning the improvements since Ericsson sent, in 1854, to Napoleon III., a proposition for a monitor vessel, Captain Noble said, in an address before the British Association, August, 1890: "Since that date—whether we have regard to our vessels of war, the guns with which they and our fortresses are armed, the carriages upon which those guns are mounted, or the ammunition they employ—we shall find that changes so great and so important have been made that they amount to a complete revolution. I believe it would be more correct to say several complete revolutions. It is at least certain that the changes which were made within the period of ten years following 1854, were far more important and wide-spreading in their character than were all the improvements made during the whole of the great wars of the last and the commencement of the present century."

Nelson's *Victory* had, at Trafalgar, 102 guns; the *Victoria*, of the present British Navy, has 44, including machine and torpedo guns. The heaviest gun of the *Victory* was three tons; the *Victoria* has guns weighing 110 tons. The *Victory* threw a broadside of 1,150 pounds with 350 pounds of powder; the *Victoria* throws one of 4,750 pounds with 3,120 pounds of powder; and its dynamic force is ten times that of Nelson's ship. The charge has been increased from 10 pounds to 1,000 pounds, and the weight of the shot from 68 pounds to 1,800 pounds.

Ericsson was not alone in his opinion as to the results to follow improvement in the art of waging war. It would not

be difficult to show that we are more indebted to the professional soldier than to the peace advocate, for our advance beyond the original condition of barbarism, when every man was on his defence against his neighbor, and peaceful industry was unknown. There is as little reason to hold the profession of arms responsible for war as there is to ascribe disease to the doctors, or sin to the clergy. Equally with them, the soldier regulates, controls, or limits disorders he has no part in creating.

As the experience of war is happily intermittent, the delusions concerning the social disorders finding their cure through this species of phlebotomy are common. Misjudgments concerning those who practise it are equally common, and the real value to the community of those whose business it is to increase the efficiency of military establishments is not understood. When Ericsson was asked how a man of his philanthropic disposition could devote his talents to improving the weapons of war, he answered that the surest way to discredit war was to direct all the resources of mechanical ingenuity to making it a pastime at which not even kings could afford to play. He believed too in the possibility of equalizing the conditions between the stronger and weaker nations; just as engineering and inventive skill have in a measure equalized the conditions between rich and poor, by placing within reach of the humblest, luxuries and enjoyments unknown to the most favored half a century ago.

Improvement in warlike appliances, and the professional study of war, tend to destroy the demoralizing sentiment of personal hostility toward a public enemy, encountered in battle. There is nothing to produce this sentiment in the breast of a man absorbed in scientific manipulation of warlike machinery, or in solving problems of logistics, strategy, and tactics at such a distance from an enemy that the loss of life, to which he contributes, figures in personal consciousness only as one item in the statistics of a great contest, or among the sounding phrases of a war bulletin. Thus emancipation from some of the worst evils of war is through men who, whether so intending or not, have accomplished a distinctively philanthropic purpose in devoting mechanical genius to the science of destruction.

Fulton, who introduced us to the steamboat, and Ericsson, who did so much to improve it, were, both of them, equally at

home in the art of destruction. Three-quarters of a century ago, Fulton, in his experiments with the *Dorothea*, gave a striking illustration of the destructive effect of a charge fired from beneath a vessel. The *Dorothea* was a Danish brig of 200 tons burden and solid construction, drawing twelve feet of water. She was anchored in the roadstead of Wermland, near Deal, England. Two boats, each carrying a torpedo loaded with two hundred pounds of powder, rowed on opposite sides of the vessel and dropped their burdens overboard. The two torpedoes were united by a cord, and as the current carried this foul of the ship's keel, one or both of them was thrown against the ship's bottom and discharged at a given moment by a clock-work attachment.

The experiment in this instance worked perfectly. The doomed *Dorothea* rose six feet, broke in two amidships, and in twenty seconds sank out of sight, leaving nothing but a floating mass of débris to show where she had been anchored. The experiment was tried in the presence of Colonel Congreve, of rocket fame, Admiral Holloway, Sir Sidney Smith, and most of the officers of the British fleet under command of Lord Keith. The complete success of this Yankee infernal machine produced due astonishment, but was without other result. Pitt and Lord Melville were at first disposed to encourage Fulton, but Count St. Vincent said, with great force: "Pitt is the greatest fool that ever lived to encourage a kind of warfare useless to those who are masters of the sea, and which, if successful, would deprive them of their supremacy."

Numerous attempts have been made since then to develop this form of attack, until now torpedoes, and vessels especially designed for their use, are part of the recognized machinery of naval warfare. Bushnell's "battle of the kegs," during our war of the Revolution; Nix's attack on H. M. S. *Plantagenet* in 1812; the use of torpedoes at Sebastopol and Cronstadt in the Crimean war; the destruction effected by them during the Danish war of 1864; in the Austro-Italian and Paraguayan wars of 1866; in the Anglo-Peruvian conflict of 1877; in the Turco-Russian war of 1877–78; and their more decided success as used by the Confederates during our Civil War in blowing up sixteen Federal vessels, all mark so many steps in the progress

toward their final adoption. Against them professional sentiment has protested in vain. The courtly usages of war are no longer recognized on sea or land, and the resources of modern science are exhausted in the effort to render naval combats especially, short and sharp, if not decisive. The result has undoubtedly been to make the maritime nations hesitate, more than ever before, to provoke a naval contest, as it is wholly impossible to estimate the relative value of the new factors entering into the determination of such a contest. As an officer of the U. S. Navy, Lieutenant Bradley A. Fiske, has said in a recent magazine article, "the only thing that can determine the real conditions of modern naval warfare is a modern naval war."

The tendency of military reasoning is to limit the science of destruction within certain well-defined bounds. Engineering invention seeks to develop it to the utmost, without regard to ethical considerations. Thus, Fulton's efforts to introduce his system of submarine attack into France were thwarted by the prejudices of the Minister of Marine against a system of warfare which he considered only fitted for Barbary corsairs. What will become of navies, exclaimed another French authority, St. Aubin, and where will sailors be found to man our ships-of-war, when it is a physical certainty that they may at any moment be blown into the air by means of diving-boats, against which no human foresight can guard them?

The struggle between gun and armor has continued until, if not actually determined in favor of the gun, it is certainly limiting the rôle of the armored vessel. It seems to be destined to a transformation, similar to that ascribed by the palæontologist to the free-roaming sea monster which gradually accumulated defensive scales, until its freedom of motion was destroyed, and it became the sluggish and amphibious crocodile. It is the man of genius like Ericsson who forecasts such possibilities and adapts his plans to them in the beginning, while others must travel to his conclusion by the laborious and costly methods of experience.

Acute observers are questioning whether England, and the naval powers who follow her lead, are not again wasting their hundreds of millions on vessels that, in their hour of trial, will

prove of as little value as were the thousand unarmored ships, swelling the British naval lists when the contest in Hampton Roads awakened England from her dream of security.

No man was more competent to form a judgment on this question than John Ericsson, and he was most emphatically of the opinion that the day for the sea-going armor-clad had passed. Not that vessels bearing armor were necessarily useless, but that no vessel could be built to carry on the open sea the armor needed for her perfect protection, even against the guns; while for defence against submarine attack armor was worse than useless, decreasing flotation without offering security.

"I look upon the enormous thickness of armor now being introduced in England, and the new monster guns building," he said in 1874, "as the expiring efforts of the Island Queen to retain her supremacy on the sea. The *movable torpedo* will inevitably render these efforts unavailing."

United Italy, accepting the opinion of the first Napoleon, that she could never maintain her integrity until she had become a great naval power, resolved to build vessels more formidable than any afloat, and put upon the sea the *Duilio* and the *Dandolo*, mastless turret-ships then of unusual size, 10,570 tons, partially protected with armor 14 to 22 inches thick, and carrying 100-ton guns. These were followed by the *Italia* and *Lepanto*, of 13,851 tons, carrying armor 16 and 33¾ inches thick, and each costing in round figures $4,000,000. Writing of the earlier vessels, Ericsson said: *

"In a naval point of view, I regard the construction of the *Duilio* and the *Dandolo* as the greatest folly of our time, while I consider the present contest, so much talked about, between guns and armor, as a waste of time and means. What is the use of mounting 100-ton guns and putting 24-inch thick armor on a frail raft which may be attacked by a small craft capable of approaching, in defiance of the fire of the monster guns, and capable of piercing the said raft, in spite of the 24 inches of armor? England committed a fatal blunder in following Napoleon's lead, by building sea-going iron-clads. Had you drawn on your mechanical resources and produced small

* Letters to John Bourne, January 24, 1879, and March 7, 1879.

craft, capable of sinking the cuirassed ships, other nations would never have followed the example of the man of whom history can say, that he never did the right thing. Take my advice; construct Destroyers to sink the iron-clads of designing neighbors, but let England cease to build the useless iron citadels whose bursting guns now threaten to destroy the morale of the British sailor. Do this, and your prowess and overwhelming numbers will again enable Britannia to rule the waves."

In a letter to his brother Nils, Ericsson said: "I am so concerned in the welfare of my native country that I cannot refrain from asking you to do all you can to correct the mistake of the Government in building large iron-clads. We now call such vessels 'torpedo food.' The larger, the better targets they will be for the torpedo." * These opinions were the result of Ericsson's confidence in subaquatic attack. This he believed would make it possible to sink the heaviest of armor-clads by blowing a hole in her hull far under water. Early in his career he had planned several movable torpedoes, and from the time that he introduced the present system of screw propulsion for ships-of-war in the United States, his attention was specially directed to the subject of "subaquatic" attack. The propeller was a great step in advance in this direction, as it enabled the motive power to be applied at any depth. The difficulty remaining was that of storing a sufficient amount of energy within the submarine torpedo. In a letter dated July 31, 1878, he said, speaking of the Whitehead torpedo:

"The most important part of the whole contrivance is my instrument for driving the fish ahead. You are aware that since Mr. Davidson, of Woolwich Dock-yard, copied my double torpedo propeller, Whitehead has also adopted the plan of employing two propellers revolving in opposite directions round a common centre, one behind the other. As to actuating the propeller by *compressed air*, I proposed that motor for submarine attack more than forty years ago; and before Whitehead had constructed a compressed-air engine I had built scores of such motors. As to the horizontal rudder, acted upon by the various hydrostatic pressures at different depths, all schemers

* Letter to Baron Nils Ericson, April 10, 1875.

in submarine torpedoes who preceded Whitehead, myself included, resorted to that obvious device."

Twelve years before this, in a letter to John Bourne, February 22, 1866, he had said: "The plan of firing under water has been proposed to the United States Government during the war by more than a score of inventors. Wealthy parties in Boston entered into a contract with the Navy Department to build vessels on this plan, but found, by experimentally firing guns of heavy calibre under water, that it was impossible to produce the destructive effect promised; consequently they abandoned the contract, after having spent a large sum. Several inventors, some from Sweden, have sent me plans of underwater artillery. The subject has engaged my attention for thirty years. It is not promising." Again he wrote, saying: "More than thirty years ago I devised the method of employing a 'movable and adjustable base' from which submarine torpedoes could be despatched toward any desired point. I forwarded, in the month of September, 1854, plans and descriptions of this method to Emperor Napoleon III., the documents being presented by the Swedish Ambassador at Paris. The modification of employing a tubular cable attached to a reel applied on board of some small iron-clad vessel, was perfected before the conclusion of the late war."

These statements carry back Ericsson's first suggestion of the device described beyond the time when Samuel Colt made his experiments with torpedoes in New York Harbor. It was on the 4th of July, 1842, that Colt blew up the *Boxer* off Castle Garden, and in October following the *Volta* in the Potomac, in the presence of the President, members of the Cabinet, General Scott, and thousands of spectators. This was followed, April 13, 1843, by the blowing up of a brig of five hundred tons from Alexandria, Va., at a distance of five miles from the point where she was passing under sail. The next year Congress voted to purchase Colt's invention, the secret of which is said to have died with him in 1862.

The scheme of naval warfare submitted to Napoleon III. in September, 1854, was not revealed by Ericsson until it became necessary to defend himself against the claims of priority of invention raised by Captain Coles. Nor was the full scheme

even then made public. It included a plan for submarine assault and this was reserved for future contingencies. From the illustrations supposed to represent the drawing submitted to the Emperor of the French, this was omitted, and is here for the first time presented on pages 238 and 239 of volume i.

At that early date Ericsson clearly apprehended the conditions which, in practical experience, have always controlled naval warfare, and must continue to control it to the end. However we may extend the range of artillery, naval engagements must be settled at close quarters. The ram, on which so much reliance is placed, requires actual contact, as do fixed torpedoes, while the auto-mobile torpedoes can only be operated effectively from the near distance. Ericsson's studies, as early as 1845, had shown that the law of parabolic progress, controlling projectiles flying through the air, does not apply to bodies propelled through water, and having the same specific gravity as the water. These proceed in a straight line until their motive force is exhausted. Applying this principle, he proposed to adopt the most obvious method of submarine attack, that of piercing a ship's hull by an explosive projectile expelled from a tube lying near the bottom of the attacking vessel, and communicating with valves at each end. One of these valves was to be closed behind the projectile, to shut out the water from the tube, and the other opened in front of it to admit of its passage on its submarine journey.

The limited range of such missiles, and the difficulty found in controlling their course, induced Ericsson to first attempt some other method of accomplishing his purpose. Accordingly, he published, in the spring of 1870, a description of a torpedo to be moved and directed by compressed air, communicated through a flexible tube, payed out from a reel on board the torpedo or from one on shore. Four years before this date, in November, 1866, he had communicated the details of this system to the King of Sweden and Norway, and to his friends, Count B. Von Platen, Swedish Minister of Marine, and Commodore A. Adlersparre, Assistant Minister of Marine.

Believing that by means of his invention aggression might be effectually resisted, he published to the whole world a description of his apparatus, so minute and exact that any intelli-

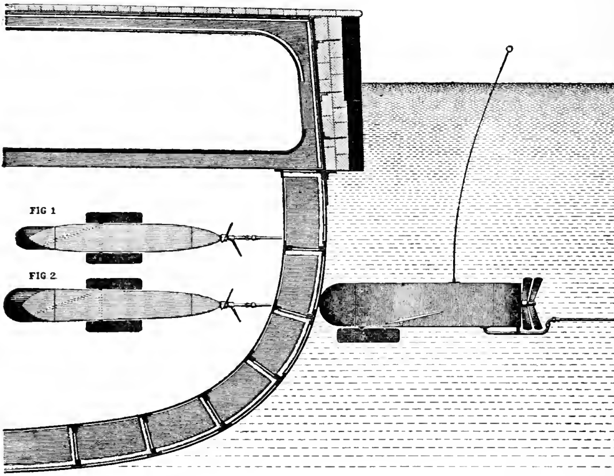
gent mechanic could construct it. His sympathies were always against the powers disposed to infringe upon the liberties of others, and his brains always at the service of those whose attitude was that of defence against them. He sent his descriptions and drawings to professional papers here and in England, and forwarded copies to Vice-Admiral Porter (April 13, 1870), to the Chief of the Naval Bureau of Ordnance, and to the Naval Committees of the Senate and the House of Representatives. He also entered upon a controversy to establish the superiority of his system over that of other locomotive torpedoes. The scope of this device, as he took pains to explain, was limited. Yet he said: "Had the Italians possessed it, the result at Lissa would have been different. They could have turned the tables on the Austrians who made such havoc with their rams. No harbor can be entered which is protected by it; nor would any amount of vigilance save vessels from destruction on an enemy's coast defended by it. . . . My object in giving an account of my labors connected with submarine warfare is simply that of demonstrating the futility of encasing ships of war with huge masses of iron, and showing the absurdity of wasting millions of tons of coal in propelling weight which does not protect." *

In connection with his description of this new locomotive torpedo, Ericsson made public the details of his plan of attack by guns mounted behind armor, and firing elongated projectiles designed to enter the water at such an angle as to pierce a vessel's unarmored hull. Lest he should be accused of plagiarism in his method of loading his guns by depressing their muzzles below the water-line, and inserting the projectile from the hold, he said: "I feel called upon to state, that loading guns below deck, as here shown, was planned by me, and drawings representing this method exhibited in New York several years before it was claimed by certain American engineers as their invention."

He had such confidence in his plan of attack, that he proposed, as already stated, to furnish at his own cost and risk, a swift screw-vessel, provided with a pair of 15-inch smooth bore guns, and the necessary apparatus for sinking by submarine ex-

* Letter to London Engineering, dated March 11, 1870.

plosion a vessel of the average draught of the iron-clad fleet of England, while she was being towed at the greatest speed possible, or performing whatever evolutions her owner might prefer, with the distinct understanding that the attack was to be made at a less distance than 500 feet. "If," he said, "a first-class swift iron-clad ship, say the *Devastation*, unassisted by other craft, will meet in open water a vessel constructed agreeably to the new system, it is contended that the latter



Torpedo Actuated by Compressed Air Transmitted through a Tubular Cable.

will sink the breast-work monitor in spite of her guns, and notwithstanding evolutions designed to avoid the submarine missiles."

The Navy Department were in receipt of various communications from Ericsson at this time on the subject of his system of naval attack, but, perplexed by innumerable projects recommended to them for defending our harbors, they were unable to come to any determination. Ericsson was confident that professional sentiment would come around to him in time,

and he wrote to Commodore Adlersparre: * "It is well I have not been hasty in carrying out the amphibic projectile, since naval tactics have in the meantime been quite revolutionized in consequence of the adoption of the Harvey torpedo and the boom torpedo, both of which call for fighting at close quarters. Had I, four years ago, proposed to fight at a distance of 500 feet (the best range for the amphibic weapon), my opponents in the American Navy would have proved such a short range to be an insuperable objection. But *now* those opponents are daily exercising their crews in the art of destroying their enemies by exploding powder bags at the end of booms only twenty feet long!"

For several years the controversy which Ericsson had inaugurated continued, and if he did not succeed in establishing professional confidence in his own schemes of submarine attack, he did succeed, by his powerful logic and his convincing array of facts, in demonstrating the futility of other schemes. A Naval Board reported favorably on a torpedo actuated by the generation of carbonic acid gas, and controlled by electricity transmitted from the shore through an insulated wire. In a series of vigorous articles, Ericsson demonstrated the weakness of this form of attack. He proved by a mathematical demonstration, from which there was no escape, that three-quarters or four-fifths of the explosive force of the five hundred pounds of nitro-glycerine proposed as a charge for this torpedo, would be wasted, so that the actual force would be the equivalent of only one hundred pounds of explosive distributed over six square feet of armor-plate. He pointed out very clearly the difficulty, if not the impossibility, of getting the torpedo in question into a position to exert even this amount of force, with a vigilant enemy on the defence against it.

The result was a challenge from the proprietor of the torpedo in question, Mr. Lay, to a competitive trial, with a forfeit of $10,000 by the defeated party. This challenge was accepted under certain conditions, but these were not found acceptable. The two torpedoes were, indeed, so unlike that it was impossible to agree upon a common ground of comparison. As neither of them was a success this is immaterial. In the case of

* Letter to Commodore A. Adlersparre, January 23, 1874.

Ericsson's, it was found that the drag of the hollow cable carrying the air from the compressor to the torpedo, so interfered with the steering that the torpedo was nearly unmanageable. The controversy between the two inventors served, however, to clear the way for something better than either of their devices, by convincing Ericsson that he had not yet accomplished the result he was after.

The controversy here referred to was carried on by Ericsson through the columns of the *Army and Navy Journal*. To the editor of that paper finally wrote Commodore William N. Jeffers, Chief of the Naval Bureau of Ordnance, one of the most intelligent and capable Bureau officers the Navy has ever known.

> There is no doubt but that at present we are completely at sea on the torpedo question, and on taking charge of this Bureau my very first efforts were devoted to obtaining some practical results. The pole torpedo has been fully developed, but we now want something more. The Lay machine requires too many favorable conditions. The Whitehead, once launched, is like a blind man striking out with a club, as likely to hit friends as enemies. Torpedo warfare is not yet developed, and cannot be studied or taught as a system. Experiment is the only course to adopt, and I intend to carry on a full course. I intend going over to New York as soon as the weather becomes settled, and I wish to have a talk with Ericsson about his torpedo, and arrange for experiments with it; I hope also to have some amicable understanding with the army, and that we will not devote our talents to demonstrating how very little either of us know on the subject.*

This was followed by a visit to Ericsson in the company of the recipient of this letter, who seems to have been invited by Commodore Jeffers to accompany him somewhat in the character of a body-guard, the Commodore having the mistaken impression that the great engineer was not an agreeable man to meet; an impression resulting wholly from Ericsson's determination to protect himself against miscellaneous and useless visits. The visit of the accomplished naval officer resulted in an agreeable acquaintance, having its foundation in mutual confidence and respect. Commodore Jeffers was a man of

* Letter of March 7, 1874, to William C. Church, Editor Army and Navy Journal, New York.

sufficient ability to be willing to meet Ericsson on his own ground. Having confidence in himself, he did not feel compelled to resort to the arts by which lesser men seek to hide their insignificance behind the curtain of official reserve, and to swell their own piping tones by sounding them through the trumpet of high station. He was not one of those who imagine that the height of the pedestal determines the size of the man.

Of Commodore Jeffers's visit, Ericsson wrote to Adlersparre: *

Notwithstanding my attack on the Navy Department, the Secretary has been forced to make the first move in effecting a reconciliation, and accordingly ordered the Chief of the Bureau of Ordnance, Commodore Jeffers, to call on me last Saturday. The meeting was of a most friendly nature, and resulted in my offering the tubular cable torpedo for trial, if the Government would provide a good vessel and pay the cost of a powerful air-compressing machine, the one I employed last year having in the meantime been disposed of. The Commodore at once authorized me to build such a machine to suit my own views, and did not even ask to see my plans. Accordingly, I am now at work constructing a perfect machine for supplying air and operating the reel. In the meantime, a fine new vessel, built by the Government at Boston, is being fitted up for trial, and will be ready within two months. Your humble servant is certainly one of the most fortunate individuals that ever lived. Without having made any application, a great naval power thus asks my assistance to help it out of the defenceless condition in which it finds itself, owing to the want of sufficient iron-clads. The *intended* imposing naval display at Key West has suddenly disclosed the unpleasant fact that the nation possesses no ships capable of meeting an enemy, and that our great Atlantic cities may be destroyed at any moment by foreign iron-clads, unless we can meet them with *movable* torpedoes. Grant and Robeson now at last comprehend the matter, hence their willingness to give me a hearing.

July 1, 1874, a few months after the interview he had held with Ericsson at the latter's house, in Beach Street, New York, the Commodore wrote officially, saying:

I have to acknowledge the receipt of your letter of July 1st, enclosing diagrams and explanations of a system of tactics of a movable torpedo (Tubular Cable System), which I have carefully examined, and the

* April 10, 1874.

movements described are perfectly feasible. I fully agree with you that there is very little hope of successful results in making the attack from long distances, and therefore it is unnecessary to make any provision for such an attack. All experience shows that to obtain decisive results against such resisting objects as ships, it is necessary to seek close quarters, and particularly with this new weapon, as yet untried in actual warfare.

February 17 and March 12, 1875, Commodore Jeffers reported that a model of Ericsson's torpedo which he had received, "worked regularly without the slightest trouble, and to the admiration and surprise of everyone to whom I have shown it. I have exhibited it to other chiefs of the several Bureaus and other naval officers, who were free in their expressions of wonder and satisfaction at the successful manner in which it operated."

Commodore Jeffres placed at the disposal of Ericsson a smooth-bore 15-inch naval gun with its carriage, mounted on a Navy Yard scow. With this, a series of experiments were conducted at Sandy Hook, and these established practically the fact that an elongated 15-inch shell forming a torpedo projectile ten feet in length, designed to carry dynamite or other high explosive, could be fired in any desired direction, from an ordinary smooth-bore gun, using a small charge of gunpowder as the motive force. The plan embraced a revolving turret for protecting and directing the guns.

This turret Ericsson regarded as absolutely indispensable, but it did not meet with the approbation of Commodore Jeffers, who believed that a suitable carriage mounted on a ship's deck would answer the purpose. "This modification of my system," said Ericsson, "involved so much imperfection that I respectfully declined to adopt the same. A change of Administration occurring at the time, the experiments at Sandy Hook were discontinued. This abrupt termination induced me at once to elaborate the more effective and less expensive plan of blowing up iron-clad ships by means of submarine guns and projectiles, the immediate result of my labors being the building of the *Destroyer*." *

To secure his title to originality in the use of powder, in-

* Letter to Hon. W. C. Whitney, Secretary of the Navy, October 3, 1887.

stead of compressed air, for propelling high explosives, Ericsson published some account of his experiments; but, as he felt called upon to explain in a letter to an officer of the Navy some years later, "he refrained from particulars as to the flight of the projectile through the air, and its behavior on entering the water. This was in deference to the Navy Department and the opinion of the Chief of the Bureau of Ordnance, who had to some extent committed himself in favor of expelling torpedoes from decks of vessels." The results were not favorable to further experiment.

The project of building the *Destroyer* followed as the direct result of the encouragement received from Commodore Jeffers, who was a full convert to Ericsson's views except in matters of detail.

With the approval of the Chief of the Bureau of Ordnance, Ericsson made a series of experiments on the Hudson, the result of which he reported to Jeffers, saying:

I beg to inform you that I have concluded the torpedo experiments on the Hudson, the result having fully realized my expectations. Recent developments in submarine attack, especially the various means suggested and partially adopted by the English Admiralty, in order to protect their large iron-clad ships against torpedo attack, have convinced me of the correctness of the principles involved in the plan submitted to Emperor Napoleon III., 1854, viz., that of employing swift *impregnable* screw-propelled vessels, provided with means of projecting torpedoes under water at moderate distances. The extraordinary speed attained by first-rate English armored ships, and the apparent impossibility of building *small* vessels of equal or superior speed, capable of resisting modern rifled ordnance, have deterred me from prosecuting my original plan. But having recently planned a vessel on a peculiar cellular system (near and above water-line), in which all vital parts are deeply submerged—thereby dispensing with other armor than that requisite—to overtake first-class armored ships no longer presents an obstacle. The favorable result of the trial of the wooden torpedo, together with the positive determination regarding *form*, induced me, immediately after the conclusion of the experiments, to construct a machine for projecting a large torpedo under water. The work was pushed with such vigor that all was ready for trial by the end of last week, the trials being now ended.

A patent for this invention has just been granted by the United States Patent Office; but, as I have applied for a patent in England, the

American patent will not be issued until after the publication of the English grant.

So far, the problem of destroying armored ships may be considered as practically solved. The possibility of constructing an impregnable vessel *faster* than the British iron-clads, and capable of withstanding their fire, remains to be established. This I am prepared to do, no financial difficulty standing in the way; but it would be very desirable to know if the Navy Department could purchase such a vessel at actual cost, or for a certain specific amount, when finished and tested. Please give me your views on this point.*

On December 17, 1877, and again on April 1, 1878, Ericsson wrote to Commodore Jeffers, reporting progress with this vessel, named by him the *Destroyer*. In the second letter he said:

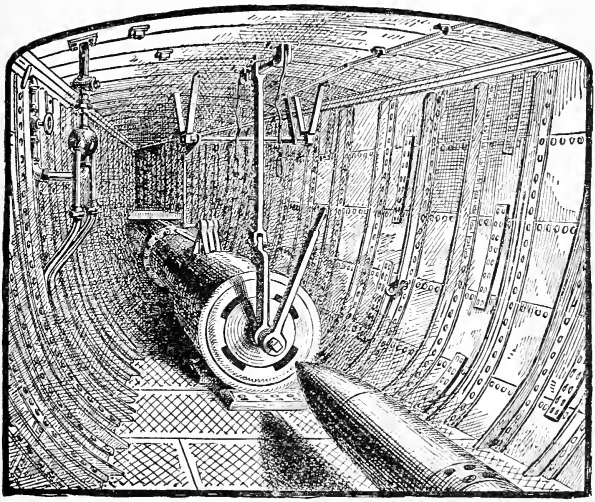
The English appear to be at their wit's end with reference to torpedo warfare. Notwithstanding Lord Beresford's assertion, in the House of Commons, that the Whitehead torpedo is perfection, leaving nothing further to be desired, the Admiralty have been experimenting with all sorts of torpedoes and submerged rockets. The *Laboratory Torpedo* (devoid, it appears, of the intricate motive mechanism of Lord Beresford's pet weapon) the English people now imagine will protect their fleets in future, since it is capable of running great distances at fabulous rates. But no way has yet been found out by the Admiralty of making the wonderful *Laboratory Torpedo* hit a vessel whose commander is disinclined to remain stationary while the missile is approaching; nor has it been found out how to induce a current, running across the path of the torpedo, not to interfere with its course. Consequently the Lords of the Admiralty have now decided to build torpedo conductors of two thousand five hundred tons burthen, to carry their wonderful chemical torpedo up to the point intended to be struck; truly a sensible plan. In the meantime let us show that we possess very simple means for destroying both the intended huge torpedo-carriages and the latest iron-clads supposed to be invincible.

In reply to this letter Commodore Jeffers wrote officially, saying: "I have had the pleasure of receiving your two letters with sketches of your new torpedo system, and have delayed a reply while submitting them to several officers of judgment. The remarkable simplicity of the arrangement commends it to every practical man as compared with the Whitehead or Lab-

* Letter of December 7, 1877.

oratory, which I take to be a reproduction of Sir William Congreve's water rocket." *

Again the Commodore wrote, "I think the days of heavy iron-clads and monster guns are numbered, all of which is to our advantage, as we possess none of either. The simplicity and efficiency of your torpedo, as compared with the Whitehead, gives us the power of using a charge sufficient to insure



Interior of the Destroyer, Looking toward the Bow.

the destruction of an opponent, no matter where he is struck; and the sea-going qualities and speed of the *Destroyer* will enable us to break up any attempt at a blockade." †

In his letter of April 7th, Commodore Jeffers had suggested a dry tube for firing the torpedo from directly ahead to abeam. In reply Ericsson showed the impossibility of this with a torpedo thirty feet long and a vessel with beam "forward of the

* Letter of April 6, 1878.
† Letter of September 23, 1878.

transverse armor plate," averaging seven feet. Continuing, he said: "Permit me to state that my sole object of building the torpedo vessel has been that of demonstrating, practically, that iron-clad ships of all classes may be destroyed in spite of the power of their ordnance and thickness of armor. I therefore trust that you will approve of my course in excluding from the *Destroyer* all contrivances which are not needed to carry out the scheme of blowing up vessels by means of a projectile torpedo *capable of cutting through temporary protections, and discharged in a direction parallel with the keel at so short a distance that it cannot miss the body attacked.*"

In November, 1878, Ericsson's friend, G. V. Fox, wrote from Washington: "I have had a long talk with Jeffers, I am happy to say that he is very much impressed with the idea that you have adopted to attack the present system of iron-clads, and that he shares my confidence in its complete success. I am sure that your invention will become as national as the monitor."

"I have always been of the opinion," said Commodore Jeffers, speaking for himself, "that this system offers greater promise than any other plan of offensive torpedo warfare, from its simplicity; and when all the details have been worked out, have no doubt of its adoption to improve torpedo vessels. I shall be glad to assist in any way in my power." *

Discouraged by later experiences at Washington, Ericsson wrote to Commodore Jeffers, July 20, 1880: "The apparent indifference on the part of the Government relative to the *Destroyer*, indisputably the most powerful means yet devised for defending our harbors, has induced me to adopt a course enabling me to prosecute the great scheme by private means." Continuing his experiments, he exultingly announced to his friends, the Delamater Company, eighteen days later: "Iron-clads are doomed. Our torpedo, with the propelling piston bolted to its aft end, went yesterday 275 feet in a direct course under water and then floated to the surface. The torpedo yesterday was not fully loaded, hence did not go as far as it might. Enough was accomplished, however, to show that we can sink an enemy without ram steam-launch or spar-torpedo of our navy. All these devices are now gone to the dogs."

* Letter of May 29, 1879.

CHAPTER XXIX.

ERICSSON'S PLANS FOR HARBOR DEFENCE.

Naval Approval of the System of Subaquatic Attack.—Opposition of the Bureau of Ordnance.—Ericsson's Persistence.—President Garfield and General Miles.—No Coast Defences Needed.—How to Defend Our Harbors.—England's Critical Position.—Unreliability of Torpedo-boats.—The Admiralty and the *Destroyer*.—Turrets for Land Defence.

COMMODORE JEFFERS was relieved from the Naval Bureau of Ordnance July 1, 1881, and his successor in office was not favorably impressed with the *Destroyer*. Contrary to the opinion of his predecessor, he held that the projectile of the submarine gun should have more range, ignoring the fact that the range of a missile fired under water is very limited, and that, aside from this, for longer range greater velocity is essential, and that the necessary light projectile would be shattered by heavy charges.

A naval board, having Commodore Selfridge as its chairman, reported that the Ericsson submarine torpedo "is a projectile of the most formidable character within a limited range, and within that range, whatever further experiments may prove such to be, it is superior to any known form of torpedo." Admiral Porter, the head of the Navy, held the torpedo in similar high esteem, and recommended that one be discharged from a distance of 200 feet, as at that distance the projectile could not miss nor the enemy escape. He interested himself in securing from Congress an appropriation for the purchase of the *Destroyer*, and urged that Ericsson keep his invention a secret from foreigners. In one of his annual reports, he recommended that twenty steel vessels be built on the Ericsson plan, with quadruple expansion engines to secure a speed of thirty

miles an hour, which would make them the perfection of torpedo-boats.

But the new Chief of the Bureau of Ordnance was not satisfied with these opinions, and he insisted on conditions Ericsson found it impossible to comply with. The *Destroyer* must not only be more thoroughly tested, but the test must be made at the inventor's expense, and at sea, in spite of the fact that the vessel was not built for sea service. Her guns must also be tried with high explosives. In vain Ericsson showed that this would subject him, in the event of any accident, to the penalties of manslaughter, or at least to heavy damages, as his vessel did not hold a Government commission. He had long been in the very awkward position of navigating in the crowded waters of New York Harbor a vessel having no legal status, and had had to pay one heavy bill for damages resulting from a collision. It was in vain, too, that he showed the unfairness of requiring him to add twenty thousand dollars for these experiments to the hundred thousand dollars already expended in solving a problem of national defence, of chief interest to the Government and to every citizen equally with the inventor.

"My object," he said, "in building the *Destroyer* has been simply that of demonstrating the practicability of submarine artillery, unquestionably the most effective, as well as the cheapest, device for protecting the seaports of the Union against iron-clad ships. I do not seek emoluments, as I am financially independent; but I am anxious to benefit the great and liberal country which has enabled me to carry out important works which I could not have carried out on a monarchical soil. I am also anxious to silence my opponents abroad, who assert that the worthlessness of the *Destroyer* is proved by its being rejected by the United States Government." *

Mr. C. H. Delamater had through his firm furnished one-half of the money to build the *Destroyer*, and he was thoroughly tired of the long delays in securing its adoption. His interest in Ericsson also prompted him to protest against his devoting to such thankless public service any more of a life now fast drawing to a close, for Ericsson was an octogenarian.

* Letters to Hon. W. E. Chandler, Secretary of the Navy, September 29 and 30, 1884.

"My old and dear friendship," he wrote, "prompts me to follow what I have said with humble advice to abandon the whole subject—to let the *Destroyer* lie as she is, in the Navy Yard and unnoticed, and to devote your energies to genial and pleasant themes and experiments. As your friend—to whom your past has been a most interesting volume, and to whom your future is as dear—I would gladly see you devote all your fortune, principal and interest, and combining it with your life, spread it over twenty years to be gone at the end of it—excepting only something in moderate degree for those only who have devoted their lives to yours, and ignoring all others whose claims would be only those of sentiment without service."*

But Ericsson was not to be persuaded, and continued to the end of his life to interest himself in the *Destroyer*, though he had very little faith in his ability to secure an appropriation for it from a Congress which had not been able, in forty years, to find time to cancel the debt incurred in connection with his work upon the *Princeton*, in 1842. He twice submitted an offer to the Navy Department to build an improved *Destroyer*, with a guarantee of success, relieving the Department of all responsibility, but these offers were declined.

The patriotic General Nelson A. Miles, of the army, who was deeply solicitous on the subject of the inadequacy of our coast defences, warmly interested himself to secure the adoption of the *Destroyer* by the Government. Writing to Ericsson, June 9, 1883, he said: "The week preceding the tragedy which resulted in the death of President Garfield, I had a conversation with him on the subject, by the sea-side at Long Branch. He took a deep interest in the matter, and said that he intended to give it personal attention, and endeavor to bring the Navy up to its proper standard. Of course, his death prevented the realization of his desire, but I still hope our Government will appreciate the importance of your life work and most valuable inventions, and that you may be duly rewarded for the eminent and valuable services which you have rendered the nation."

At the second session of the Forty-ninth Congress, a bill

*Letter of November 22, 1882.

was introduced to appropriate $2,000,000 for the *Destroyer*, and ten enlarged steel vessels of the same type, but it did not become a law. "The success of the *Destroyer*," wrote Ericsson,* "would destroy the prospects of the powerful fortification and gun interest, which looks forward to an expenditure of one hundred millions within a few years. Then we are opposed by the iron-clad ship building and armor-plate combinations; not to mention torpedo-boat builders, submarine boat projectors, and dynamite gun manufacturers, all against us, as their plans will be worthless if foreign iron-clads can be shattered and our harbor defended without guns and fortifications, by the employment of the simple and cheap submarine artillery system."

In other letters † Ericsson had previous to this expressed the decided opinion "that this country requires no coast defences. Small states, surrounded by powerful neighbors, bent on landing armies on their coasts, need such defences, but the United States needs only harbor defences to prevent an enemy from destroying the great seaboard cities. Well-informed men now admit that no fortification could prevent the *Inflexible* from entering our harbor and burning New York." "For that purpose," he added, "nothing has yet been devised that can compare with the *Destroyer* system—submarine artillery." After a thorough study of the subject, Lieutenant William H. Jaques, one of the intelligent and well informed officers of the Navy, said: "In some countries where the torpedo-boat has entered as a permanent element of defence, the great value of submarine gunnery is conceded. In this connection it can be said without doubt, that the *Destroyer* represents the most advanced experiment."

Ericsson believed that with his submarine guns of large calibre swung at their sides, the monitors could be made serviceable for harbor defence, their lack of speed not preventing their use in this capacity. In a letter of April 9, 1880, to Commodore Edward Simpson, U.S.N., he said:

A monitor, however powerfully armed, is no longer capable of defending the harbor of New York against an *Inflexible* or *Dandolo,* since

* Letter to Honorable A. H. Cragin, September 22, 1886.

† Letters to R. B. Forbes, June 9 and November 29, 1884.

the 2,000-pound projectiles would utterly destroy both turret and pilot-house. The stationary torpedo, with its delicate gear, may be easily destroyed, while ships of the class referred to can pass the forts with perfect impunity. How then are we to protect the wealthy city, it will be asked. Admiral Ammen will answer: "Employ that infallible representative of 'naval economy,' the *Marine Ram*." "But," says the practical engineer, "the marine ram by which you propose to assail the side armor of the *Inflexible* near the water-line, will inevitably be destroyed on encountering the resistance of her great mass, while no serious injury will be inflicted, since the convex form of the bow-lines of the marine ram will cause its entire forward part to bulge outward on striking the massive iron-clad. The constructor of the steam ram will then probably say: "I can make those lines perfectly *straight* and prevent bulging outward." The practical man will then object that if the motion of the ram, running at full speed, be instantly arrested, the entire steam machinery, boilers and all, will be displaced, the steam connections broken, and the ships company scalded to death by the escaping steam. It may be demonstrated that no engineering expedient can avert such a catastrophe.

Again, if the form of the proposed puny steam ram be modified so that it can strike *below* the armor, only a single one of the numerous water-tight compartments of the *Inflexible* would be pierced. The steam ram, if constructed as shown in the work referred to, would, of course, on striking go to the bottom, with its displaced machinery and broken steam connections. It may be asserted, therefore, that the scheme of sinking *Inflexibles* and *Dandolos* by "economical" steam rams, will prove futile.

The *Destroyer system* on the other hand, based on the plan of running within a few hundred feet of the assailant and then projecting a torpedo containing an explosive charge capable of blowing up the hull of the intruder, will probably prove an infallible mode of protecting our Atlantic cities against the supposed invincible European iron-clads.

"One hundred vessels like my original *Monitor* could not now," he said in a letter to Hon. S. S. Cox, M.C., in 1855, "prevent the destruction of New York by a small squadron of first-class iron-clad ships."

The cost of one turreted vessel like the *Inflexible*, with its armament, is $3,250,000. For this sum a fleet of Destroyers could be built, and one-half the three hundred and fifty men composing the crew of an *Inflexible* would be sufficient to man them all. To the four heavy guns of the larger vessel they would oppose thirty submarine cannon, each having the huge bulk of the armor-clad as a target for its five hundred pounds of some high explosive. Was it not better, Ericsson

argued, to distribute the risks of war among thirty vessels than to concentrate them in a single huge craft? and could there be any doubt that the advantage would rest with the power thus securing the superior weight of metal—or in this case, of explosive?

On June 23, 1875, Ericsson had written to Commodore Jeffers, saying: "After thorough consideration, I have abandoned the idea of taking out a patent for the torpedo, trusting to the liberality of the Government to pay for the invention in case its success should warrant its adoption. I cannot overcome my reluctance to teach the whole world what I deem it my paramount duty to give only to the American Republic, and to my native land. Persons looking at my torpedo think they know all about it. Such, however, is by no means the case; we *have* secrets to keep."

This referred to his cable torpedo. His experience with the *Destroyer* later on convinced him that his only hope of securing a trial of the invention to which he had devoted so much labor and thought, and in which over one hundred thousand dollars had been invested, was by going abroad. He refused, however, to negotiate with Russia, replying to an inquiry from the Russian Minister that he had not authorized anyone to offer the *Destroyer* for sale.* The information of this refusal was at once telegraphed to King Oscar II., of Sweden.

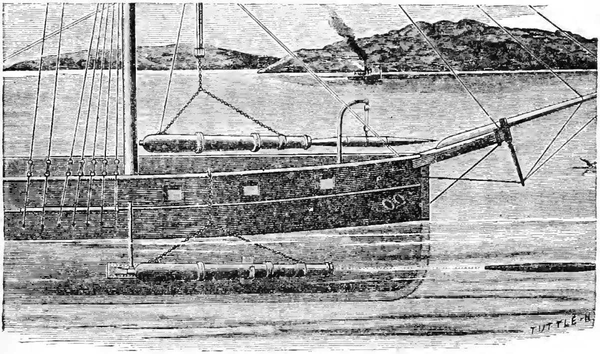
In a memorandum furnished to a representative of the Peruvian Government, November 20, 1879, when Peru and Chili were at war, Ericsson said:

1. Captain Ericsson's strong desire to have the *Destroyer* tested in *actual war* induced him to offer the vessel to Peru. Finding, on inquiry, that the United States Government will not permit this engine of war, as it is termed, to leave the country for the purpose he intended, he now withdraws his offer. It will be proper to mention that Captain Ericsson has received a bona fide offer of £10,000 for the *Destroyer*, by a certain European government, provided he will guarantee a speed of *sixteen* nautical miles an hour.

Peru adopted the Ericsson plan of applying the submarine guns to ordinary ships in 1879, but, owing to the blockade, a

* Telegram to the Russian Minister, February 7, 1879.

specimen gun sent to a Peruvian port had to be carried over a roundabout road across the mountains. It was not received until Admiral Grau was dead, the *Huascar* taken, and the Peruvian vessels it was intended to defend against the Chilians had been destroyed, with one exception, by those energetic people. The gun was experimented with on land and threw a projectile of solid yellow pine, 19 feet 11 inches long and weighing 1,040 pounds, with a nine-pound charge of Peruvian powder, on a straight course, 450 metres, or nearly 1,400 feet. A second shot went 800 metres, and a third 900 metres, or over half a mile.



Method of Firing the Sub-marine Gun from an Ordinary Vessel.

Negotiations for the sale of the *Destroyer* were also carried on by the Chinese authorities, but they did not lead to any result. Finally, Ericsson resolved to offer the vessel to England. In a letter to a family connection, Mr. S. B. Browning, he wrote:

England's critical position becomes more serious with every day. The fact that you cannot carry on the puny war in Egypt without depriving the country of its only trained protectors, the *Guards*, shows a weakness which the friends of the great nation notice with dismay. Yet the Admiralty does not comprehend that the safety of the country depends wholly on the power of the navy to protect the seaports against the impending coalition of maritime nations. Nothing, absolutely noth-

ing, is now being done to defeat such a coalition by adequate *naval* protection. Admiral Hobart's contempt for the locomotive torpedo is a grave mistake. No iron-clad ship in existence is safe if surrounded by a fleet of these puny assailants, unless provided with torpedo guard that can be dropped down in an instant and raised again, after the destruction or departure of the despised craft.*

Such a torpedo guard Ericsson devised. It was intended for war equipment only and, having been previously fitted, a few days sufficed for its application. It was submitted to the Admiralty, but did not meet with favor. "England," Ericsson said, "in case of war with Russia will, as a matter of course, send her ships to blockade the Russian ports in the Baltic. Considering the overwhelming number and excellent condition of the torpedo-vessels in the Gulf of Finland, handled by plucky officers and well-trained crews, I regard the destruction of the English blockading ships as inevitable, unless efficient means be resorted to for protecting their hulls against Russian Whitehead torpedoes."

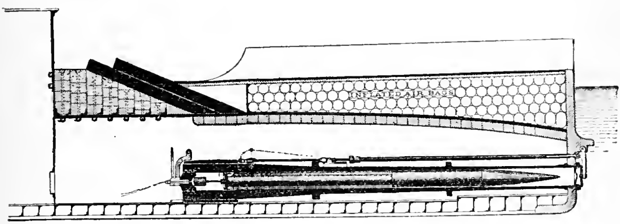
Brennan's torpedo, adopted by the British Government, he described as "a mere mechanical toy, in some respects inferior to Lay's kindred, frail, and complicated device." "Hobart Pasha's favorable opinion of stationary torpedoes, based on his experience acquired on an inland sea without tides, merits no consideration," he said, "in a country on whose shores there is a change of sea-level exceeding forty feet every six hours. It would be a fatal blunder to act upon the assumption that English seaports can be defended by stationary torpedoes, in the face of the established fact that such frail protection can be destroyed or removed wherever the enemy desires to enter."

Warning England against reliance upon torpedo-boats, he further said: "A single modern fast cruiser, provided with numerous breech-loaders of great range, could sink a whole fleet of torpedo-boats at a distance which would render the locomotive torpedo of no use as a means of defence against the cruisers bent on laying a seaport under contribution."

Even the forts and guns of New York Harbor, though incapable of destroying iron-clads, could "send all the torpedo-boats of Europe to the bottom in a few hours." Seaports

* Letters of February 20 and June 12, 1885.

without forts could be protected against torpedo-boats by temporary earthworks, mounted with artillery of almost any kind. Such works could be constructed in a few days, and at small cost, as was demonstrated during the late American war. To the argument that the torpedo-boat could be accompanied by a cruiser carrying heavy ordnance, he replied that such a cruiser would be met by other cruisers with equally heavy guns, or by a vessel such as the *Destroyer*, with ordnance which could send the cruiser to the bottom by a single shot below the water-line. The contest then would be between these vessels, with the torpedo-boat serving as a mere spectator, if indeed it had not already been sunk by the hostile cruiser at long range. The torpedo-boat can never carry heavy ordnance, and will "never



Longitudinal Section of Destroyer, Showing Gun and Projectile.

be employed against seaports of any importance. Moreover, when doing constant duty during war, the boasted speed of the fast torpedo-boats would soon fall below the speed of modern cruisers. The engines of the cruisers moving comparatively slowly, while their boilers are capacious and numerous, their speed can be maintained, as is that of the Atlantic steamers, which keep up their extraordinary speed all the year round.

A British officer, Lieutenant Gladstone, R.N., sent to this country, made so favorable a report upon the *Destroyer* that one of her submarine guns and four projectiles were purchased by the Admiralty. These were tried, but in such shallow water that they struck the bottom, ricochetted, and went to one side, instead of going straight ahead, as heretofore during

trials with a submarine gun suspended under a scow in twenty feet of water. Two projectiles were tried under these disadvantages. A third was next discharged, loaded with three hundred and twenty-one pounds of gun-cotton,* but a Woolwich detonator had been substituted for the percussion lock furnished with it and the charge prematurely ignited, shattering the powder chamber of the projectile and the extension of the chase of the gun. The gun being the property of the Admiralty, Ericsson had no control over it. He immediately offered to furnish a new gun at his own cost, but the offer was not accepted, and no further trials took place, a change having occurred in the Admiralty meanwhile.

The inventor was able to console himself for his disappointment at the result of the trial of his submarine gun in England by the reflection that "the Admiralty lords will in good time adopt the new system of destroying an adversary, just as they adopted the screw propeller after having utterly condemned the same, in spite of my successful demonstration in the Thames on the memorable occasion when, by means of the submerged system of propulsion, I towed the gorgeous Admiralty barge, with its precious freight of nautical wisdom, from Somerset House to Blackwall and back, at the rate of ten knots, everything working to a charm." †

The idea of projecting torpedoes through horizontal tubes by means of compressed air, included in the scheme laid before the Emperor Napoleon in 1854, has been generally adopted. As early as 1874 it was in use by the Austrians in the gun-boats *Gemse* and *Seehund*, by the British in the *Oberon*, by the French in the *Catenat*, by the Italians in the *Tripoli*, and by the Germans in the *Basilisk*. His original scheme of naval warfare, as presented to Napoleon in 1854, shows how clearly Ericsson comprehended the conditions that were to control the future of naval warfare. He insisted upon short range, and though the development of naval artillery, including quick-firing guns, has destroyed the force of some of his arguments in favor of "close quarters," the necessity for it still remains. His labors at that time, as he stated in his communi-

* On the beach, at Pembroke, England, September 30, 1886.

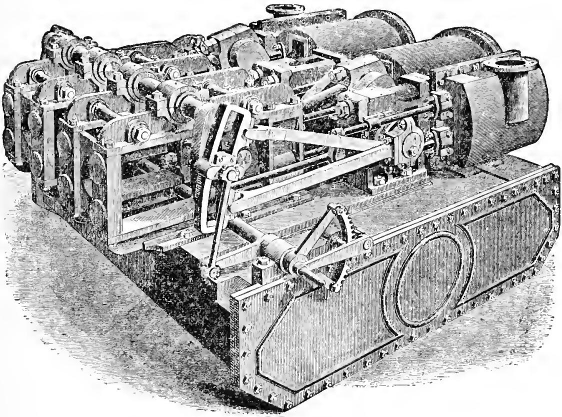
† Letter to S. B. Browning, November 10, 1886.

cation to the Emperor, were directed to the solution of the following problems:

"I. A self-moving shot-proof vessel." This was developed in the *Monitor*.

"II. An instrument capable of projecting very large shells at slow velocities, but very accurately, in accordance with determined rates." This took shape in the submarine gun, as subsequently applied to the *Destroyer*.

"III. A shell adapted to such a gun." This, described as the



Motive Engine of the Destroyer.

1,000 indicated horse-power. Base, 8 feet square, total height, 4 feet 8 inches. [Designed by John Ericsson, 1878.]

"hydrostatic javelin" in the communication to the Emperor, was the torpedo projectile finally adopted for the *Destroyer*.

It required the pressure of war to overcome naval inertia sufficiently to secure the adoption of the *Monitor*, and it will no doubt require a similar experience to develop Ericsson's ideas of subaquatic attack. It was in his mind during our Civil War, but necessity did not call for its production, and he reserved it for a greater need. His declared purpose was "to protect the weak by killing the strong aggressor."

The subject of adapting the monitor turret to land defences was considered by Ericsson during the closing day of the American Civil War. On March 11, 1865, Brevet Major-General J. G. Barnard, "Chief Engineer Armies in Virginia," wrote to him, saying, "I have long had it in mind to consult you concerning the practicability of mounting 15-inch guns for land batteries in turrets." General Barnard then unfolded his plan for building casements of masonry with iron turrets mounted upon them, and asked Ericsson for an opinion concerning these. In reply he said: "Your plan of employing wrought-iron turrets mounting 15-inch guns, for land batteries, is unquestionably superior to any defensive system yet devised. . . . I shall be happy to take the blacksmith's part in carrying out your desirable plan whenever you command me."

A discussion followed as to the comparative merits of the turret system and the arrangement of shields with embrasures adopted in Russia, General Barnard, in asking Ericsson's opinion, saying: "Your great experience in these matters would be almost indispensable in arranging details and machinery." Ericsson furnished a demonstration of the fact that the energy of a 20-inch solid shot was more than sufficient to knock over the Russian superstructure, and that of the 15-inch shell to destroy it if planted in the right place. "Its imperfections in principle and detail," he said, "as compared with the turret system, are palpable and almost innumerable."

The judgment of Ericsson and General Barnard in this matter has been fully approved by the subsequent adoption of the system of steel turrets for land defence. Ericsson furnished a design for land turrets for the defence of Sweden. These were very complete, and he found use for them a little later on, when in August, 1871, he was called upon to furnish a scheme for defending the Dardanelles with rotating turrets. The plans submitted to the Turks included every detail of specifications for "a first-class coast-defence turret on Ericsson's system, arranged for guns firing projectiles weighing one thousand pounds." The turrets were to cost, complete, ready for shipment, so that they could be set up and the plating put in place in Turkey, $225,-000 each, including two gun-carriages, two port-stoppers, and a pair of steam-engines.

Ericsson was twice called upon to give his opinion of the best means of defending the harbor of New York. In March, 1863, the Harbor Defence Commission, presided over by Mayor Opdyke, asked his advice. There was no time for preparation, as a foreign attack seemed to threaten, and it needed no demonstration at that time, as Ericsson said, "to prove that, however perfectly our forts might be mounted and manned, the hostile fleet of armor-clads would approach the city unscathed. As the East and North Rivers divide the island into two easy ranges, the enemy's shells might convert the magnificent metropolis of the western world into a heap of smoking ruins in a single day."

In default of a sufficient number of monitors to defend the city, he proposed to seal up the harbor by means of an impassable, impregnable barrier. He estimated that five thousand tons of wrought iron, and one million cubic feet of timber, would suffice to close the Narrows. Such a barrier could provide for a free passage of vessels, the operation of closing it occupying only a few hours, and it could be blown up by the military engineers if taken possession of. "Fort Lafayette," he said, "is fortunately situated to prevent, by its powerful guns, such an attempt, and the obstructions would compel them to remain under fire. These obstructions could be completed within four months, and there was no time to be lost. For, unless the English Government promptly puts a stop to the completion of the numerous piratical vessels now being built in the several ports of the United Kingdom, the ship-owners of the United States, to save their property from entire destruction, must withdraw their vessels from every sea—a humiliation which the Union cannot submit to."

Nearly a quarter of a century later, Ericsson returned to the subject in a letter addressed to the President and members of the New York Chamber of Commerce.* With this he sent a chart of the Bay of New York, prepared for the purpose of showing what is needed for its defence. With reference to this, he said: "The *blue lines*, drawn from Forts Tompkins, Hamilton, and the forts at Sandy Hook to the centre of the enemy's fleet, near Coney Island, show that unless the guns of

* Letter of January 13, 1887.

said forts are capable of destroying twenty-inch thick armor at ranges varying from six to seven miles, the attacking ships can accomplish at their leisure the destruction of your great city."

Monitor turrets mounted on land, with Destroyers floating on the water, would, as Ericsson believed, furnish the cheapest as well as the most complete system of defence possible. For two millions of dollars, he offered to build ten Destroyers within twelve months, armed with submarine guns of sixteen-inch calibre, and protected by inclined breast-armor of steel plates, capable of resisting the projectiles fired from one hundred-ton guns. To attempt to defend every point at which an enemy might glide along a long coast line, if not practically impossible, at least involved a heavy expenditure. This he believed might be saved by the adoption of such a system of movable defence as he had long before proposed, and had advocated from the time when the floating turret made its début in Hampton Roads. "The important feature," he wrote, "of the monitor turret, that it offers absolute protection to guns and gunners, at the same time subjecting an approaching enemy to the annoyance of being at every instant in the line of fire, is all-sufficient to recommend the turret system in preference to all others involving embrasures and a combination of iron and masonry. Let us bear in mind that a monitor turret, which requires only a raft for foundation, may be erected in any locality, at small cost."

Ericsson was always a disbeliever in large vessels for home defence. His attention was first directed to the subject practically in 1838, and five years later he proposed to defend the American coasts by gunboats small enough to be put on cars and transported wherever needed. "How different the American conflict would have been from the start," he said in a letter written soon after its close,* "if the Republic had possessed the fifty gunboats which I proposed twenty-five years ago. A thousand millions of money could have been saved and lives numbered by tens of thousands. But, as a cool head observed at the time, the idea of putting on a railway fifty gunboats demanding almost no outlay to keep in repair, ready to be sent into the water at the first sound of the war trumpet, is too simple

* Letter to Commodore Adlersparre, November 6, 1868.

and common-sense sort of an idea to be adopted by Congress. Many similar observations," he adds, "were made at the time by my friends."

On April 27, 1887, Ericsson wrote to the Secretary of the Navy, Mr. Whitney, stating that he had just completed the plan of a harbor defence vessel of the *Destroyer* type, 24 feet beam, 13 feet deep, carrying a protecting belt of steel armor 3 inches thick and 30 inches deep, extending around the outer hull. This armor, backed by oak planking $3\frac{1}{2}$ inches thick, was sufficient protection against the fire of machine-guns, and the vessel, when trimmed for conflict, would be nearly submerged. The portion of the cabin projecting $3\frac{1}{2}$ feet above the main deck was similarly protected. The breast armor for protection against heavy guns in fighting bows on, consisted of inclined solid compound steel plates 30 inches thick, backed by 6 feet of oak timber. This statement was accompanied by an offer to build such a vessel for the sum of $275,000.

The steel cruisers, built by the Navy Department during Mr. Whitney's administration, Ericsson unsparingly condemned. The Secretary having expressed a wish to converse with him on the subject of the Navy, he wrote, November 4, 1886, showing that these vessels were useless for war purposes as their boilers were wholly unprotected. They should have been placed below the water-line and out of reach of the enemy's fire. He sent a diagram to show how shot, penetrating the thin hull and the frail $1\frac{1}{2}$ inch "protecting" deck, would destroy the high-pressure boilers, allowing the steam to instantly fill the boiler-room and scald the firemen to death. Low boilers of the torpedo type, besides being out of reach of an enemy's fire, would give more room for coal and secure protection for the boilers by a mass of coal sixteen feet thick on each side of the boat.

CHAPTER XXX.

CONTRIBUTIONS TO STEAM ENGINEERING.

Improvements in Steam Machinery.—Changes in Methods.— Ericsson and his Critics.—His Advanced Ideas.—Difficulties with which he Contended.—Competitive Trials between Engines.—The *Madawaska* and *Wampanoag* Controversy.—The Expansion Engine.

ERICSSON'S failure to accomplish his purpose of substituting hot air for steam, may perhaps explain the fact that he has received less credit than was his due for his constant contributions to the improvement of steam machinery. Of the inventions, or engineering devices, included in his list of over one hundred prepared in 1867, nearly one-half are improvements in the application of steam-power. Nor does this by any means show all that he accomplished, for, up to the end of 1883, he had planned and constructed more than one thousand different models and machines.

The changes in steam machinery, during the period of Ericsson's active labors, were so rapid, that again and again was it found necessary to sell nearly new vessels at less than one-half of their original cost, and to replace them with others fitted with more perfect machinery. The number of hands employed for each one thousand tons capacity of British steam vessels was reduced forty per cent. by economical changes adopted during the fifteen years succeeding 1870. The expenditures of coal had been so lessened meanwhile, that it was possible to carry 2,200 tons of freight with 800 tons of coal, where it was before only possible to carry 800 tons of freight with 2,200 tons of coal. Sir Lyon Playfair estimated that at the end of this period "a small cake of coal, which would pass through a ring the size of a shilling, when burned in the compound engine of a modern steamboat, would drive a ton of food and its proportion of the ship two miles on its way from a foreign port."

So many have contributed to this result that it is impossible distinctly to define the services of any one man. The advance has certainly been along the line of Ericsson's studies, and his labors had an important influence upon this progress. In the employment of artificial draught, of the surface condenser, the hydraulic reversing gear; in his devices for heating the feed-water and superheating steam, and in his use of the compound principle and twin screws, he made at a very early date an intelligent application of the ideas involved in the improvement of steam navigation. It is only within recent years that those who travel upon the waters have reaped the full benefit of these early labors of Ericsson and others. So late as 1868, Vice Admiral Sir Edward Belcher, K.C.B., in an address before the Institute of Naval Architects, asserted that at that date there had been no increase of speed over that attained at the opening of the century with masts and sails.

The progress of improvement in government vessels has been much less rapid than in the mercantile marine, and that it has not lagged still farther behind is due in large measure to John Ericsson. His labors in connection with screw propulsion; for the simplification of marine machinery, and for securing its protection by placing it below the water-line and surrounding it with coal, unquestionably revolutionized warfare, and made the use of steam possible.

If it be contended that Ericsson might have accomplished more had he been less aggressive, it should be remembered that conciliation means compromise, and that radical changes do not admit of compromise. As it was, he truthfully described himself, in a letter to an intimate friend written thirteen years before his death, as "the person who has done more to promote marine engineering, mechanical motors, implements of naval warfare, etc., than any other ten persons together during the last third of the lifetime of the American Republic." Opposition is the inevitable accompaniment of progress. Ericsson labored in departments of mechanical change where this was most sure to assail him. Inventive progress, during the three-quarters of a century covered by his career as an engineer, was continually opposed by ideas originating in methods continuing substantially unchanged since Adam delved and

Eve span, and down to the commencement of the present brief era of mechanical achievement. Ericsson not only had this opposition to overcome, but he contended against ingrained professional prejudices, formulated in "customs of the service," and established in the traditions of a class the most thoroughly organized for resistance to innovation. What engineering and mechanical science have done for the art of war, has been done at the cost of abdication by purely military men of something of their high prerogative of command. Thus Ericsson represented to them the idea of substituting engineering talent for fighting ability; the transfer to others of some of the functions of war heretofore monopolized by the admirals, the field-marshals, and the major-generals. It is not in human nature for the vanquished to crown the victor with laurels, and the class who really owe the most to the man who has conquered them on the field of prejudice were naturally slow to accord him honor.

The chief of lessons to be learned by our land forces during our great Civil War, preliminary to victory, was the lesson of self-sacrifice and disregard of personal comfort. The ragged battalions of Stonewall Jackson, living upon the handfuls of corn plucked by the wayside, were alike the terror of, and an example for, the pampered soldiers from the North who, in the early days of the war, sought to carry the comforts of civilization into the field. If in the end they learned their lesson thoroughly, they learned it most unwillingly, and only at the cost of great sacrifices in pride, in blood and treasure. It was Ericsson's mission to teach this lesson of simplicity in personal equipment to our marine forces, and the result upon his personal popularity among them was inevitable. It was only under the strain and stress of war that the value and significance of his labors were appreciated.

Ericsson defied the experts, matured his plans, applied them as opportunity offered, and after a prolonged contest compelled their general acceptance. The struggle was an exhausting one, and he bore the scars of it to his grave. "The bitter and unjust remarks of the editor of *The Engineer*," he once said, "is only a repetition of what I have experienced through life, simply from the fact that in my profession I know more than most other people. Not one in a hundred of those critics who have

assailed me, and by their injustice rendered a life otherwise fortunate, often very unpleasant, would have done so had their experience and knowledge not been inferior to mine. It is my consolation, however, to feel that those only who do not know me accuse me of ignorance in my profession, and that those who know me best have least to say against me." *

It was by studying simplicity and compactness of construction that Ericsson was able to make the most effective application of the steam-engine to naval vessels. His engines, from those applied to the little tug *Stockton*, 1839, to those designed twenty-three years later to furnish 4,500 horse-power to the large *Dictator*, "had one feature in common"—bringing the power of two engines to bear at right angles upon a common crank-pin. Watt suggested the idea of a piston vibrating within a semi-cylinder; Ericsson developed it most successfully in the *Princeton*, and applied it in a modified form to his steamers, *Edith* and *Massachusetts*. When, in 1859, the United States Navy Department sought for the best screw propeller engine, Ericsson presented a modification of his semi-cylinder engine, in the form of a single cylinder divided midway by a steam-tight partition, so as to form two cylinders, in each of which moved a piston, the two pistons working in opposite directions, but connected with the same crank on the propeller shaft by levers, rock shafts, and connecting rods.

In 1866 (April 20th), the London *Engineer* said of this engine: "It has been almost universally applied to the late vessels of war in the States, and also in the mercantile navy of that country. There is not a single American monitor without an engine of this kind, and all the Swedish monitors are engined on the same plan." In the engines of the *Dictator* the cylinders were placed vertically side by side.

Their designer has left on record, in his volume "Contributions to the Centennial Exhibition," a technical description of these engines, as well as a defence of them against adverse criticism. "From the *Monitor* to the *Monadnock*," said Ericsson, in a letter to Bennett Woodcroft, May 15, 1866, "not in a single instance have these engines heated or been out of repair during the war. In fact, their success has been unprece-

* The London Engineer, March 21, 1890, p. 234.

dented. The *Dictator's* engines, which have *upright* cylinders, troubled us for some time, but were finally made to work perfectly cool."

These engines are to be judged by their time. They were not intended to attain the high economy possible with superheated steam, high expansion, and surface condensation, but only to work with certainty with the ordinary jet condensers, ordinary steam, and ordinary expansion.

A most favorable report was made of the Ericsson engines upon the *Penguin*, a gunboat purchased by the Navy Department at the outbreak of the civil war, early in 1861. At the end of eleven months Mr. Delamater reported that she had been under steam every day of that time, seven days excepted, and had not been stopped once on account of derangement, nor had she had a hot journal, and was in complete condition at the end of the eleven months, although the engines had been in use over three years.

"I have never failed," Ericsson said, in 1854, "to carry engineers with me when we have been confronted. Nor is there, to my knowledge, an adverse engineering report printed or written against me--I mean, of a formal character. Some few private letters and sundry stabs in the dark are all I know of. What was the result of my bold start with Collins, when I advised and he agreed to use the oscillating engine? 'May I submit your plans to *practical* engineers?' was the query. 'Certainly,' said I, 'provided I have the privilege of making my own representations.' Now, Morgan and Secor happened to be my worst opponents at the time, and they had a man of the name of Gorga, the great genius of their establishment, who it was supposed would knock me into pie. Well, the meeting was arranged; cold and incredulous faces surrounded my drawing-table. The explanation commenced; the cold faces soon warmed, and at the conclusion of my lecture, Mr. Gorga not only agreed to my several propositions, but he saw a number of advantages I had omitted to state. But so it has always been. I never yet failed to carry my point. Give me only the chance of a reply, and I will carry any of my plans with any board of engineers. Truth is mighty, and will prevail." *

* Letter to John O. Sargent, May 6, 1854.

In 1864, Mr. Delamater wrote: "I am most anxious to awaken your attention to the fact, that in Europe much attention is now directed to the subject of superheating, and much progress has been made. I have been satisfied, by what I have seen and by what I have heard from you, that you, for years, have been fully aware of what may be done and *how* to do it, and I trust to see you before the world as you are before me—always in the van."

Mr. Isherwood improved the occasion of the issue of a volume on "Experimental Researches on Steam Engineering," to subject Ericsson's engines to sharp criticism, and the Navy Department resolved to give Ericsson and Isherwood the opportunity to build rival engines; these engines to be tried in competition on vessels otherwise precisely alike. In spite of the fact that he was greatly at a disadvantage in competing with a head of the Bureau controlling the contest, Ericsson accepted the challenge.

A contract for building the engines of the vessel assigned to him, the *Madawaska*, was signed by Ericsson on December 17, 1863. The rival ship was the *Wampanoag*. The *Madawaska*, subsequently known as the *Tennessee*, was not launched until July 8, 1865. Ericsson, with his usual energy, pushed his work ahead so fast that the *Madawaska* was ready long before the *Wampanoag*, and he lost the opportunity he coveted of testing them together. The contract price for his engines was $700,000, and they cost him and his associates $940,000. As one-sixth of the price was to be reserved until after their trial and acceptance, a further burden of over $100,000 was added to his load. To Mr. John A. Griswold he wrote, September 6, 1866, saying:

"In the meantime the duns are at my door and must be got rid of. Strange to say, although I have constructed hundreds of engines and other machinery of novel and experimental character for thirty years, I now for the *first time* find myself a dunned individual. As I cannot stand it any longer, I have raised $35,000 by selling stock. This amount I am ready to give checks for, provided you will yourself furnish $15,000, and Mr. Winslow an equal amount. This being paid to our creditors, will leave a moderate balance

which the parties must agree to wait for until Congress grants relief."

He estimated that $150,000 had been lost on this contract, by pushing work with gold at 250 when other contractors did nothing, and he complained bitterly of the unjust conditions to which he was subjected by the Bureau of Steam Engineering. He was called upon to run his engines for 144 hours at top speed without being allowed the opportunity to test them by a preliminary run at sea, to give opportunity for adjusting the various parts of the machinery one to another, and to ascertain that everything was in working order. He was to be allowed "a reasonable time" to work the engines at the wharf. Then the trial at sea was to begin, and "last six days and six nights under maximum boiler pressure, the steam-blast in the chimneys to be in full operation during the whole time."

Of this Ericsson said: "An engine may work well at the dock and yet heat up the moment the engines are under full speed and the ship begins to work in a seaway. No one understands this better than Isherwood; nay, more, he knows that it is simply impossible to work an engine of such enormous power—a direct-acting 100-inch—without several weeks' previous work at sea. If any proofs were needed to show the real intention of this contractor's trial trip, we have it in the order contained in the instructions to Admiral Gregory, to force the draught in the smoke-pipes during the whole trial, and at the same time put on the steam-blast! The writer has never been in a large steamship with steam-blast applied in the smoke-pipes. The idea of resorting to such draught for six days and six nights is worthy of a madman, not to say villain. . . . The *Madawaska* will rot at the dock before I furnish engineers for a trial trip, or incur the responsibility of working Isherwood's dangerous steam traps any more."

So the vessel was sent on a trial trip against Ericsson's emphatic protest and with no one on board to represent him, and the orders were given to deduct the price of eighteen tons of coal, and the engine stores consumed in the trial, from the $100,000 reserved from the contract price. In contrast with this treatment, Ericsson pointed to British precedent, saying:

"In England contractors are treated with every possible

consideration. The desire of the Admiralty is to obtain good machinery, but not to embarrass and oppress the builder. Accordingly, the ship is put in commission and run for the benefit of the contractor, and not until *he* reports that the machinery is in good working condition, is the ship taken and run the 'measured mile.' *The official trial* consists in running the vessel six times in succession over the measured mile. If all works well the ship is accepted; if not, every facility of docking is afforded and the contractor allowed another private trial—contractor's trial—before going again to the 'measured mile.'"

Ericsson's forebodings were happily not realized, and on a final trial trip the *Madawaska* established her claim to be the fastest naval vessel then afloat. February 15, 1867, Ericsson wrote to Adlersparre:

"It gives me much pleasure to inform you that my great opponent, Isherwood, has stated to members of the Naval Committee of the House of Representatives, 'that the *Madawaska* is the fastest ship of war in the world, that her rate is sixteen knots, and that she could make seventeen knots over the English measured mile.' The truth is, the success of the new engine has been so complete as to overwhelm the Bureau Chief—his policy, therefore, is to go with and not against the current, in this instance."

Eighteen days before this an officer of the Navy had written to the Assistant Secretary to say: "The *Madawaska* is the fastest ship of war in the world; no one but possibly the Bureau Chief questions the fact. As you took the responsibility of ordering the vibrating lever engines to be applied to this ship, you will, no doubt, be glad to hear what I have stated."

February 1, 1867, Ericsson wrote to John Bourne, contradicting unfavorable statements concerning his engine, and saying:

The fact is that during five consecutive hours the rate was 15¼ knots; during two hours the rate was 15½ knots, and during short intervals even higher, with less than one-fourth throttle open! No attempt was made to ascertain the speed with full throttle, as Isherwood's boilers did not admit of such a test. The engineers of the vessel say they can

readily make and hold 16 knots. Over your "measured mile," such a rate would be play. This is strictly for your own information. I have some trouble in settling with the Navy Department on account of Isherwood's opposition, and therefore must keep silent for the time being. You may judge of the importance of the matter when I state that I have expended $940,000 in building the steam machinery of this extraordinary ship—extraordinary in many respects, as you may learn some day.

To R. B. Forbes he sent, August 23, 1883, this statement of the ultimate fate of the *Madawaska*:

The *Madawaska* was laid up because a Board of Experts had removed from the vessel one-half of her original boiler-power, the remaining half being utterly insufficient to supply steam for the two 100-inch cylinder engines without running at so slow a rate that the centres could not be passed. I have neither the time nor inclination to furnish the history of this remarkable ship.

In 1881 Captain Ericsson built a single cylinder, non-condensing steam-engine, capable—according to a calculation he has left on record—of making more than two thousand turns in a minute. On the second trial he reported that it developed 12.3 horse-power with a speed of 1,230 revolutions in a minute. The steam pressure admitted to the valve-chest was 55 pounds per square inch, working with half-expansion. The single vertical cylinder was 5 inches in diameter and 3 inches stroke. The weight of this little engine, independent of the friction pulley, 15 inches in diameter, was 353 pounds. During a continuous run of eleven hours and twenty-five minutes, this engine made 732,340 revolutions, an average of 1,069.1 revolutions per minute. After the first quarter of an hour there was no perceptible variation in speed during the run. The steam pressure in the chest stood very uniformly at 25 pounds. The boiler pressure varied between 55 pounds and 85 pounds. Steam expands so quickly that it will follow up without loss of pressure a piston moving at the rate of 1,000 feet in a minute.

Ericsson informed his friends at this time that, before he discontinued his labors, he should present to the world a steam-engine which would practically develop the entire dynamic en-

ergy of the steam, "thus putting an end to further improvements and speculation as regards steam consumed and power produced." He hoped to "materially benefit civilization, by checking the rabid exhaustion of the coal fields which threatens to put a stop to human progress in the not distant future." This purpose he believed to be realized in an engine patented in the United States, December 6, 1887, and intended to convert steam into work, altogether independent of the method of its generation. It performed, he reported, "the astounding mechanical feat of developing a perfectly uniform power by expanding steam thirty-six times. The engine was constructed with two cylinders only, their pistons being connected with the same piston-rod, and receiving the pressure and expansive force of steam on one side only. Thus each cylinder and piston was single-acting; the high-pressure piston during the entire stroke produced by the direct action of the steam upon it, working against a vacuum, the low-pressure piston being the same time in equilibrio." To this engine, patented in the United States, June 17, 1887, he gave the name of "Ericsson's Expansion Engine."

Mr. Egbert P. Watson, in the article already quoted from, says: "Ericsson was a scornful disbeliever in multi-cylinder engines. He asserted that these were only devices of English engine builders to increase the cost, and he denied that multi-cylinder engines were necessary to economy, or to high ratios of expansion. He asserted that a two-cylinder engine could be made to show as high economy as any other, all things being equal, and he constructed one of sixty horse-power, and ran it at the Delamater Works for a year or so. This engine produced a horse-power for fourteen pounds of water, and showed high efficiency."

While recognizing its advantages for actuating screw propellers, Ericsson regarded the triple expansion engine as very defective in principle, for a motor intended to develop the full energy of steam, besides being complicated. His expansion engine was intended for electrical purposes, and such an engine should, he contended, be non-condensing, as water for condensation cannot be obtained in large cities. It was accordingly adapted to working without condensing the steam, or in other

words, converted into a high-pressure engine—a type of engine performing nine-tenths of the service which mankind derives from steam. This engine expanded the steam sixteen-fold; as compared with the thirty-six-fold expansion of the condensing expansion engine. For this engine the claim was made that it developed a greater amount of power, with a given quantity of coal, than any other steam-engine thus far presented to the public. Ericsson believed that it would ere long revolutionize engine construction. To it he devoted the last labors of his life, and he was engaged upon it at the time of his fatal illness. Less than five weeks before his death he wrote a long letter concerning it to Mr. S. B. Browning, his wife's nephew, upon whom he had bestowed the patent rights for New Zealand and Australia.

In this letter he said: "The Non-condensing Expansion Engine has been completed some time. It is the most economical high-pressure engine in existence, design and workmanship never having been excelled. . . . The power of our engine cannot be superseded by future inventions, as it develops all the dynamic energy which a given weight of steam contains."

On March 2, 1888, Ericsson wrote to Mr. Browning, saying: "The actual power of the expansion engine, with and without condensation, has proved an unexpected success. Indeed, it is regarded as a revolution in hydraulic engineering, since it admits of running the pumps at one hundred and fifty strokes per minute without occasioning any concussion whatever in the delivery pipes which convey the water to distant points. Some of my friends say that the hydraulic machine is as important to our rapidly increasing towns as the motor which actuates the same. You must, therefore, not be surprised if you find my name again among applicants for English patents." This hydraulic machine combined an air-pump with a force-pump, in such a way as to relieve the piston or plunger of the weight of the column of water set in motion at each stroke. This made it possible to work the pump at a high velocity.

The condensing expansion engine was one of the last enterprises in which Ericsson was engaged with his friend of half a century, Mr. Delamater. When finished, it was set at work running machinery of the Delamater Iron Works, and a hy-

draulic machine raising three hundred thousand gallons of water one hundred feet high in twenty-four hours.

Mr. Delamater's letters show that he had his doubts as to the commercial value of an engine carrying two hundred and twenty-five pounds pressure, when the public had been educated not to expect over one hundred pounds in stationary engines; locomotives and steamships using one hundred and sixty pounds. Other engines of the non-condensing compound type claimed equal advantages of simplicity, economy, little clearance, high speed, automatic lubrication, compactness, and neat design. He warned his friend, in short, that the world was moving faster than he supposed; that many Columbuses were learning to set the egg on end.

CHAPTER XXXI.

HONORS CONFERRED UPON ERICSSON.

False Reports of Ericsson's Death.—Invitation from the Crown Prince of Sweden.—Appointed Commissioner to the Paris Exhibition.—Receives the Thanks of the Swedish Riksdag.—Honorary Degrees Conferred.—His Relation to His Profession.—Monument Erected at His Birth-place.—Ericsson's Opinion of the American Congress.

FROM a Swedish paper Ericsson learned, in 1879, that a rumor was afloat in his native country that he was to be appointed to the Cabinet of President Hayes as Secretary of the Navy. He telegraphed contradicting the report, and saying: "I do not desire to occupy a position the duties of which no one but a sailor can properly discharge." The probability of such an appointment may be judged from the fact that General Nelson A. Miles, U.S.A., states that when he spoke to President Hayes of Ericsson he replied that he supposed he was dead.

M. Pierre Larousse, in his "Grand Dictionnaire Universel du XIXme. Siècle," edition of 1870, had announced that John Ericsson "*mort en* 1869 *à Richland* (*État de N. Y.*) *des suites de la morsure d'un chien enragé.*" Drake's "Dictionary of American Biography," published in 1872, made the same statement, fixing the date of death as March 5, 1869, and omitting the explanation that it was due to the bite of a mad dog. The "Catalogue of Wesleyan University" changed the date to 1870, and the locality to Stockholm, Sweden. As a proof of the statement to appear in the catalogue was sent to Ericsson, he was able to demonstrate that he was still alive by returning it with a correction.

In 1866 a great industrial exhibition was held at Stockholm, and to this Ericsson was invited in a letter addressed to him by the President of the Commission, the Crown Prince, after-

ward Oscar II. A translation of his letter with Ericsson's reply is here given :

STOCKHOLM, May 4, 1866.

TO THE CAPTAIN, COMMANDER, ETC., ETC., JOHN ERICSSON : When a private individual gives fêtes he seeks to surround himself with a circle of near relatives and friends, and to bring together the most distinguished among his acquaintance.

So also at public fêtes is a nation desirous, and very properly, to have as guests those men who hold high place in its regard and pride, and who through their genius and distinguished personal services have benefited their country and excited admiration throughout the world.

Sweden, your native land, is soon to give a great and significant fête. Here, in her beautiful capital on the shores of Lake Mälaren, opens, June 15th, a grand industrial and art exhibition common to the entire North, viz., the three Scandinavian peoples and Finland.

The arrival here of John Ericsson would be greeted with rejoicing by every Swede, and the fatherland would receive a fresh proof that her memory is cherished and beloved by her energetic and distinguished son, resident in a distant land.

As I have the happiness to be at the head of the coming Industrial Exhibition, the honor belongs to me to express the wish that our national festivity may be heightened by your presence. And I feel confident that this wish is participated in, not only by the Central Committee, but also by every thinking man in Sweden.

With distinguished regard and true feelings of affection,

OSCAR.

NEW YORK, May 29, 1866.

TO HIS ROYAL HIGHNESS, THE DUKE OF OSTERGOTLAND : Your Royal Highness's gracious and encouraging communication of May 4th I beg most humbly to answer by the statement that work of such importance has been entrusted to me as to render my absence from America, at present, impossible. I lack words to express my gratitude for your Royal Highness's condescending goodness in sending me an invitation to visit the fatherland during the coming significant national fête. Significant in many respects, but most because directed by a prince uniting with the highest attainments and the soundest judgment, in all that concerns our practical age, a profound knowledge and the warmest feeling for the liberal arts.

The spirit of our times is somewhat too utilitarian. How fortunate, therefore, that the grand Scandinavian Industrial and Art Exhibition is under your Royal Highness' guidance !

The works of the mechanic, the tasteful creations of the architect, the faithful coloring of the painter, the sculptor's successful copy of the sublime perfection which pervades animate nature—all these will now

meet equal justice, since the eye of the judge is keen enough to view the entire field!

The occasion commands me to mention that your Royal Highness's poetical works have afforded the Swedes on this side of the Atlantic the greatest enjoyment. The many hidden beauties of our powerful and sentimental language, which your Royal Highness' genius calls forth, charm with their clear sound the Swedish ear, perhaps more here than in the fatherland. We hear so seldom the strains from our native land that when your Royal Highness tunes the lyre we listen more attentively, and enjoy more than our brethren at home.

Your Royal Highness' faithful servant,

J. Ericsson.

In August, 1866, Captain Ericsson was offered by the Department of State at Washington the appointment as Commissioner to the Universal Exhibition at Paris. After delaying for some time to see whether he could not arrange to accept this compliment, he was compelled to reply that he could not secure his release from existing engagements. In return he received a polite expression of regret that he was obliged to decline. His pre-occupation with the work of defending Sweden by sea and land was his excuse. That he appreciated the honor is shown by the fact that he wrote to his brother, saying that it was the greatest honor that had been conferred upon him, as he was, strictly speaking, ineligible, being himself known as an inventor.

Concerning the Centennial Exhibition at Philadelphia, Ericsson wrote: "I cannot imagine what we have, excepting the multitudinous mechanical Yankee notions, to show persons who have visited the grand European exhibitions. It is hardly worth crossing the Atlantic to see ship-loads of quartz, iron ores, and other minerals displayed by mining speculators, trunks of trees twenty-five feet in diameter, California apples thirty inches in circumference, nor even Washington's sword and breeches."

In 1865 Ericsson received a resolution of thanks from the Swedish Riksdag, or Parliament, conveyed by King Carl XV., under the royal seal and signature. This was the first time that the Swedish Diet had bestowed such an honor. As the motion to pass such a vote originated in the lower chamber, there was at first some objection to it in the aristocratic upper house,

but it was finally adopted without further opposition. Previous to 1862, Ericsson, besides his decoration as Knight of the Order of Vasa, had been chosen a corresponding member of the Franklin Institute, Philadelphia, Pa., an honorary member of the Royal Military Academy of Science of Stockholm, and an honorary member of the Royal Military Academy of Sweden. In 1862 he received the Joint Resolution of thanks from the United States Congress, and a resolution of thanks from the legislature of the State of New York, the Rumford gold and silver medals, and a gold medal from the Society of Iron Masters, Sweden; 1863 brought to him the diploma of LL.D. from Wesleyan University, and he was chosen an honorary member of the Society of Man-of-Wars Men, Sweden; a Knight Commander with the Grand Cross of the Order of the North Star, and a Commander of the Order of Saint Olof.

In acknowledging the honor conferred upon him by Wesleyan University, Ericsson said:

> It may not be inappropriate under the circumstances to state that, while I am not very familiar with Homer and Virgil, in the exact sciences I am quite at home—nothing within the range of mechanical philosophy is strange to me. Pray do not misconstrue the object of this statement, made solely for the satisfaction of the academical authorities, who have probably transgressed strict rules to give a marked expression of approbation in my behalf.
>
> I thank you cordially for the very kind manner in which you have conveyed to me the pleasing information that I now hold the honorable degree of Doctor of Laws of the Wesleyan University.
>
> I am, sir, very respectfully, your obedient servant,
>
> J. Ericsson.
>
> To Joseph Cummings, President of Wesleyan University.

In 1868 came the degree of Doctor of Philosophy from the Royal University of Lund, and honorary membership in the Society of Workmen, Sweden; honorary membership in the Royal Scientific Society of Upsala followed in 1869, and in 1870 honorary membership in the Physiological Society of Lund, the Spanish Order of Isabel la Catolica, already alluded to, and the decoration of Knight Commander, first class, Danish Order of Danneborg. The Society of Practical Engineering and the Society of Sciences, Göteborg, Sweden, and the Ameri-

can Philosophical Society elected Ericsson honorary member in 1873. The American Society of Civil Engineers and the U. S. Naval Institute bestowed this honor in 1879, and the Society of Mechanical Engineers in 1882. The next year the last named society elected him Vice-President, but he was compelled to decline the honor. A gold medal was awarded by the Emperor of Austria in 1877, and in 1886 King Alfonso of Spain bestowed the Royal Letters Patent of a Knight of the Grand Cross of the Order of Naval Merit, with the White Badge and Star.*

In 1868 Ericsson received and declined an invitation to serve with Professor Henry, of the Smithsonian Institution, and Professor Hilgard, of the Coast Survey, on a committee to select a meter for use in the collection of the tax on spirits.

To the American Society of Civil Engineers, Ericsson sent a letter declining to accept the honor tendered him, for the reason that it had been too tardily conferred. He briefly reviewed his engineering work, and said: "Posterity will infer that, since the Board of the American Society of Civil Engineers could not possibly have been ignorant of what I accomplished, circumstances unknown to the public must have compelled these men to withhold my name. In order, therefore, that I may not be subjected to uncharitable innuendoes, now or hereafter, I respectfully ask that you will not inscribe my name on the list of Honorary members of the American Society of Civil Engineers."

* The Order of Vasa was founded by Gustavus III., in 1776, to reward important service to the nation. The Order of the Polar Star is conferred for zeal in the promotion of public good and useful institutions. The Order of St. Olaf was founded in 1847, to commemorate the monarch who introduced Christianity into Norway, 1015. It rewards patriotism and distinction in the arts and sciences. The Order of Isabella the Catholic was founded in 1815, to reward loyalty to the royal house of Spain and the defence of the Spanish possessions in America. It confers personal nobility, and the Grand Cross, bestowed upon Ericsson, the title of "Excellency." This title and the honors due to a lieutenant-general go with the decoration of the first class of the Danneborg. It is only by special favor of the king that entrance to the highest class of the Danneborg is allowed without promotion from a lower class. The order commemorates the tradition that the Christian knights of Denmark were inspired to overcome the heathen Esthonians by the appearance, in 1219, of a flag in the heavens.

With reference to a similar honor bestowed by another society he wrote this characteristic letter to Mr. Forbes, August 23, 1880:

Nothing could induce me to read anything that is said to emanate from the pen of J. B. Eads. I was brought in close contact with that "eminent mechanical engineer" during the war, and I found him to be a huge sham sustained by hired brains. The National Academy of Sciences at Washington, some time ago, elected simultaneously two great engineers, Eads and Ericsson, as members. On alphabetical considerations Eads name stood above mine on the list. Apart from this, the Academy ought to have elected me some twenty years previously. Under these circumstances I refused to accept the great favor, insisting that my name should be erased from the roll of honor (already printed and partially published). Of course this unprecedented refusal increased the number of my enemies in certain scientific circles. The number of *opponents* has remained stationary, as everybody was against me already.

This certainly was not the way to stimulate professional regard, but Ericsson had reasons of his own for feeling that he owed small thanks to those who create professional opinion. He thought he detected a disposition among them to ignore him or to dwell upon his mistakes, while overlooking his contributions to professional knowledge. Mistakes he made, unquestionably, but of his critics John Bourne has truthfully said, there is not one of them who would not "have been a much more distinguished engineer than he is if he had never done anything in his life except to contrive the mistakes of Ericsson." Prof. MacCord, who quotes this, further says:

It is sometimes said now, as it was often said then, in a derogatory sense, that Captain Ericsson made many mistakes, and that he persistently refused to accept the suggestions of others. It cannot be denied that both of these things are true, but the recoil of this weapon is its only dangerous feature; for due account must be taken of the new and original work which he accomplished, thereby making himself a tremendous factor in the material progress of the world during the present century. He was versatile and prolific in ideas to an extent seldom approached, his work being no less remarkable for its variety than for its intrinsic importance, while its amount was simply astounding; so that its execution, even with his unrivalled celerity, would have been impossible without uninterrupted application. Plenty there were who were

willing—many much more than they were able—to give advice. Had he taken time to listen to it all, the record of what he has done would have been much shorter than it is.

Such utterances serve only to show the depths to which it is possible for little minds to descend. For the very lowest standard by which such works as his can be gauged is that of money value; and leaving out of the account the advances which he had already made in naval warfare, and considering only the effects of his previous career upon the peaceful arts, upon commercial enterprise, and general material prosperity, it is easy to show that the gain directly traceable to his single-handed exertions is great almost beyond computation. The people were very largely indebted to him for the magnitude of the interests at stake; in a word, he had done more to develop this country than he did even to defend it. Either was a more than sufficient foundation for enduring fame, but with the latter his name will be always more closely associated by every true American; and simply as the builder of the *Monitor*, it is safe to say that the memory of John Ericsson will be green in the minds of men long after not only carping criticisms, but the critics themselves, with their records, their achievements and all shall have been sunk fathoms deep in the everlasting limbo of things forgotten.

Innumerable historical, literary, and religious organizations bore the name of John Ericsson on their lists of life members, and he received a variety of medals from agricultural societies in America and Sweden for his caloric engines applied to agricultural and domestic purposes. On the occasion of the Centennial Celebration, May 26, 1880, of the American Academy of Arts and Sciences, Ericsson was the chosen medium for conveying the congratulations of the two Swedish scientific societies recognizing him as a member. He received various invitations to lecture, but nothing would persuade him to violate his self-imposed seclusion.

Of all the honors bestowed upon him, however, no one gave him more sincere pleasure than that spoken of in this correspondence:

FILIPSTAD, October 2, 1867.

The inhabitants of the mining district of Filipstad, your place of birth, in gratitude for the love you have from the other side of the Atlantic manifested toward this your early home, decided to establish a monument in your honor at Långbanshyttan, on the spot where you were born.

A monument is now erected, and as members of the committee

charged with the execution of the undertaking, it is our duty to inform you of this.

Expressing our personal esteem and admiration for you, we have enclosed extracts from papers describing the festivities, as well as some photographs taken before and after the festival at your birth-place.

On behalf of the Committee:

A. F. Björlin, Pastor.
P. G. Victor Pallin, Physician.
Anton Sjögren, Superintendent.
T. Nyberg, Inspector of Mines.

New York, October 29, 1867.

To Messrs. Sjögren, Björlin, Pallin, and Nyberg:

My best thanks for your letter of the 2d October, enclosing the photographic views of the memorial stone which has been erected at Långbanshyttan. That my countrymen in my native province have thus distinguished my birth-place will encourage me to exert myself for the benefit of my country, which I shall never forget.

With greatest respect and affection,

J. Ericsson.

With sturdy independence the inhabitants of Filipstad had resolved that they would call on no one to assist them in this loving enterprise. Accordingly they hewed out of the granite rock of a mountain nearly a mile away, a stately stone, 18 feet in height and 8 feet in breadth at the base, and upon this they inscribed this legend:

John Ericsson
was born here
on the 31st of July, 1803.

The intention had been to dedicate the monument on the anniversary of the event it celebrated, but the undertaking was a larger one than they had anticipated, and the stone was not ready until the 3d of September, 1867.*

Then from all directions, gathered in holiday attire, this simple people, men and women, youths and maidens, to dedicate on the spot John Ericsson loved best, and where centred their own local pride, this testimonial of loving esteem. Flowers and leaves from the Vermland forest decked birth-place and monument, and the ceremonies proceeded amid calm and si-

* An illustration of this monument will be found on page 2, volume I.

lence almost devout, such as is common in this region, where the deep solemnity of surrounding nature seems to impress itself upon the minds and manners of the people. The silence was broken by the music of a hymn played by a band of the Filipstad Volunteers. Next Superintendent Sjögren appeared upon a stage erected in front of the house, and thus spoke:

If it be the duty of the Fatherland as a whole to erect costlier memorials to her famous son, it behooved us, with such simple expedients as we have, to cut on the Swedish granite the runes which will remind posterity of the day and the place of John Ericsson's birth. . . . Especially in this mining district have we felt our hearts beat faster at the intelligence of each new success, won by our great countryman having his home in a foreign country. At each new victory he has gained over difficulties, at every successful attempt to tame the wild powers of nature for the use of humanity, we have been able to exclaim: "Here John Ericsson was born!"

At these words the covering fell from the stone, the monument shone forth in the clear light of a September sun, and from the depths of the mines sounded forth the blasts that served in place of salvos of artillery. The speaker continued with the history of Ericsson, and appropriate reflections upon it, saying in conclusion that it was not alone for his great works they honored him, but before all for the patriotism glowing warmly as ever after an absence of forty years; for the confidence he had given to the Swedish nation in its ability to defend itself, and for the example he had furnished of industry, perseverance, and self-denial.

Let us sound our praises not only for the renowned mechanician and the great inventor, but also for the warm-hearted, unselfish, noble patriot—the Swede, John Ericsson.

The shouts of the assembled people were followed by more music from the band, and new volleys from the hidden depths of the mines. Printed slips, containing verses by the author of "Pre-historic Chronicles," Dean Afzelius, and from J. Björklund, Ph. D., of Göteborg, were then distributed. The party next proceeded to the shores of Lake Långban, where dinner was served beneath the trees. At a turn in the road they came upon

another monument to the brothers Ericsson. It was a cast-iron shaft, set upon a base of granite and bearing this inscription:

> In a bergsman's home at Långbanshyttan were born the two brothers—Nils Ericsson, January 31, 1802, and John Ericsson, July 31, 1803, both of whom have served and honored their native land. Their way through work to knowledge and lasting fame is open to every Swedish youth.

This monument serves at the same time as a guide-post, and on the obverse appear these words:

> "The way to the school
> house of Långbanshyttan."

The procession respectfully uncovered their heads before the monument, the band played a national melody, and when Doctor Pallin exclaimed: "Long live the brothers Ericsson!" the whole assembly joined with all their hearts.

In the crowd assembled at Långbanshyttan on that day were two typical Swedish mountaineers. The coarse features of the one, and his big leathern apron, with brass buckles, betokened a miner of the lowest grade. The other was a tall and powerfully built man, dressed in the long gray coat and broad-brimmed hat of the bergsman. His bent figure bore testimony to his life of laborious physical exertion, as well as to his years, and on his regular features rested an expression of gentleness and peace, giving proof of chastening experience and an honest life. Upon these two special attention was bestowed, for they could claim fellowship with the Ericssons in their youth, and had shared in their boyish sports upon this very spot. One was Jonas Olsson, foreman at the iron foundry, and when John Ericsson recognized his name in the published account of the proceedings of the day, he sent this letter to Adlersparre:

> It is with great pleasure I find that at the dedication of the monument at Långbanshyttan, my former playfellow Jonas Olsson, now fore-

man at the iron foundry, was present. This honorable man must have a souvenir from me. Will you excuse me troubling you again? I enclose a check for five hundred crowns, and would you please for that sum buy a gold watch and have engraved on the inside, "To Jonas Olsson from his playmate, John Ericsson," and then have it delivered to the honest workman. Could this be done through my friend Gustaf Ekman and with a little ceremony, I would be pleased.

P. S.—A contradiction in the report of the festival at Långbanshyttan I have just now discovered. They say in one place that Ekman and Olsson were the only persons there who had known me personally, and in another place they speak about "the miner in the large leathern apron with the brass buckle," as having been my old playfellow; therefore, to prevent his being jealous of Jonas Olsson, I now send a check for one hundred and fifty crowns, and I beg of you to have this little sum sent to the miner, to buy himself a warm coat and some flour for the winter. That such a monument is now erected in my native place encourages me more than words can describe. Even the votes of thanks from the Swedish Diet, and the American Congress, now seem insignificant compared to this infallible proof of my countrymen's approval. In due time the mining district of Filipstad will receive solid proof of my gratitude.

The same mail carried a letter to the Inspector of the mines at Långbanshyttan, saying: "Through Captain Commander A. Adlersparre, one thousand crowns will be delivered to you. I wish you would distribute this among the aged miners failing in health, and to widows and children of miners who are in need of help. I take it for granted that you will distribute the money judiciously, also that the execution of my commission will give you the same satisfaction as it does me to be able to help former neighbors."

Again he wrote, four days later, October 1, 1867:

My Dear Captain: What's done in haste is never done well! Immediately after I had mailed my last letter, I was very near sending a telegram, correcting the postscript in said letter. So far as I can remember, I said that I valued the monument at Långbanshyttan more than the thanks from the Swedish Diet. It is by no means the case, but it is true that I prize it more than the vote of thanks from the American Congress. And thus I expressed myself first in the letter, but fearing that you might suppose I had forgotten the approval of the Swedish representatives, I in some way entangled (how I cannot now recollect) this valuable testimonial in the sentence. Please consider

the thoughtless addition as never having been made, and you will blot from my memory a very disagreeable recollection.

Ever your affectionate and grateful friend,

J. Ericsson.

This is not flattering to the American Congress, but one of the most bitter experiences of Ericsson's life was the refusal, or neglect, of this august body to render to him his honest dues for his work upon the *Princeton*. "Rich gifts wax poor when givers prove unkind."

This refusal had been recently repeated at the time he wrote this letter. In a petition to Congress, Ericsson had called their attention to the fact that, the unsatisfied judgment of the Court of Claims represented "not only the services and expenses of two entire years exclusively devoted to this work, but all the pecuniary compensation that your petitioner has received, or can receive, for the creation of the first war steamer in any country of the class now universally adopted, not only in the Navy of the United States, but in all other navies of the world." This petition, for the payment of the award made by the Court of Claims was never granted by Congress, and shortly before his death Ericsson wrote that, "disgusted with the repeated injustice of Congress," he had requested his friend Sargent, who had for many years urged this claim, "to abstain from all further proceedings." He pursued his demand so long as he did, only because he had in the beginning associated another with him in its collection, and was no longer free to consider his own wishes and interests alone. In 1846 he had written to his attorney: "Could I only put my hand into my pocket and pay for your time and prolonged services in the affair, I would cheerfully dismiss the same forever from my mind, with a solemn vow never to seek redress before the American Congress again."

After the earlier chapters of this biography had been completed, the Committee on Naval Affairs of the United States Senate presented a report, recommending that an appropriation be made to pay to the heirs of Captain Ericsson the amount of the award made to him by the Court of Claims for the *Princeton*, viz., $13,930; but again Congress found more important busi-

ness to engage its attention, and adjourned without acting upon this recommendation. In this report the Committee says:

The *Princeton* proved a wonderful and complete success, largely due to the many new and important features invented and introduced by Captain Ericsson. It is not strange, however, that Captain Stockton wanted the greater part of the glory—such is human nature. Nine years after the completion of the *Princeton* he felt that injustice had been done Captain Ericsson in not allowing and paying his just claim. Being an honorable man, he acknowledges the obligations of the Government to the great engineer, and recommends to the Secretary of the Navy "that he be made a fair and reasonable compensation for his time and expenses while engaged in superintending the construction of the *Princeton's* machinery, etc." The Secretary of the Navy was so impressed with this recommendation of Captain Stockton, that he sent the letter to the Finance Committee of the Senate; but the session was near a close and nothing came of it.

The question may be asked why this claim has been allowed to sleep so long. Simply because Congress is not swift in hunting for buried claims, and rarely acts, unless persistently urged to do so, even in the most meritorious cases. Captain Ericsson, though one of the greatest marine engineers that ever lived, if not *the* greatest, was a peculiar man, proud, sensitive, and stubborn, and for a long time he refused to allow his friends to push this claim before Congress. He felt that the Government had wronged him, in that it had not paid his just claim, and he was not willing to beg for what was justly his own. Honorable and manly, he felt that a great Government ought to do right without unseemly importunity.

It is well known that after he had invented the *Monitor*, and his genius foresaw its success, he refused to come to Washington to explain his invention to the Navy Department, because he felt that the Government had wronged and neglected him in the *Princeton* matter. Finally, an appeal was made to his pride, and he came to Washington and explained his great invention to several of the leading naval officers, some of whom had faith in it, and others none. At any rate he made such an impression that an arrangement was made by which the *Monitor* could be constructed by outside capital, to be repaid by the Government if it proved a success. It was completed and manned just in time to meet the iron-clad *Merrimac*, in Hampton Roads, after the *Congress* and *Cumberland* had gone down to a watery grave by the powerful blows of the monster. The country knows the history of the memorable battle between the *Monitor* and *Merrimac*. In less than ten days after the sinking of the wooden ships, had not the *Monitor* appeared, the *Merrimac* would have leisurely steamed to Washington, and the capital of a struggling nation would have fallen into the hands of the enemy. If

that had happened, no man can tell what the result of the war would have been.

Captain Ericsson saved the nation, and his name and fame were heralded the world over. The principle of his *Monitor* was adopted by every naval power in the world. This country owes him a debt it can never pay.*

* See Senate Report No. 1763, Fifty-first Congress, First Session, September 19, 1890. The statement on page 150, vol i, that $2,000 was allowed Ericsson by the Navy Department for the use of the patented engines in the *Princeton* conveys the incorrect impression that this amount was received by him. The recommendation that it be paid went from the appropriate bureau to the Secretary of the Navy, Mr. Bancroft, but before it could be acted upon he went out of office.

CHAPTER XXXII.

ERICSSON'S SON AND BROTHER.

The Law of Heredity.—Nils Ericsson's Ability as an Engineer.—Correspondence between the Brothers.—John Invited to Return to Sweden.—Asked to Become Consulting Engineer for the Scandinavian Kingdoms.—His Financial Condition.—Opposition to His Brother's Change of Name.—His Opinion of the United States.—John Ericsson's Son, Hjalmar.—His First Letter to His Father.—His First Visit to Him.—Wielding the Hammer of Thor.—Treatment of Medical Experts.—Death of the Son.—Ericsson's English Wife.—His Relations to Her Family.

THE transmission by Olof Ericsson of qualities that produced two such engineers as Nils and John Ericsson, is an illustration of the law of heredity, finding further examples, in the department of engineering, in the German brothers Siemens, the French Brunels, Anthony Bessemer and his son Henry, the English Stephensons, father and son, and in the American family of Stevens. Nils, if less original, imaginative, and erratic than his brother, was hardly less able as an engineer—within the lines of precedent. He was a man of industry and energy, of sterling integrity and public spirit, and an excellent organizer, while his conservative and cautious temperament, and his skill in bending others to his purposes, enabled him to make the most of his opportunities. He retained his position upon the Göta Canal, when his brother left it in 1820, and gradually won his way to fame and fortune. He rose to the head of the canal corps, and after completing the work upon the water-ways uniting the Baltic and the North Sea—the "blue ribbon of Sweden"—he was called upon by the king to take charge of the construction of the system of government railways. This great work completed, he finally retired in 1862—the year in which his brother reached the culmination of his fame—with

the title of baron and a pension larger than any before bestowed upon a Swedish subject.

Nils sought to persuade John to follow his example in with-

Lock on Gotha Canal, Trollhattan Falls.
[Constructed by Nils Ericsson.]

drawing from active work, and urged him to return to dwell near him in the fatherland in the following letter:

To judge from your last letter, your work has not only given you honor, fame, and respect, but now also fortune. I congratulate you most heartily on this, for it is none too soon at sixty years of age. But I hope you will carry out your intention of coming home, if not to

settle, at least to stay for some time. You could not find the same sphere of action here, but you ought to see your fatherland before you are too old. You will stay with me part of next summer, we will visit Långbanshyttan together and father's and mother's graves, and have a monument erected there. You will see my works at Trollhattan, at Stockholm, and the railways, etc.; you will observe the great progress the country has made since you left in 1825. If you have succeeded in securing an amount of capital in excess of what is needed for some profitable industrial enterprise, and can possess yourself of some beautiful villa in the neighborhood of Stockholm or Gottenborg, perhaps you would like to remain here. But enough, only come home next summer, breathe the air of your native land, and select a place for the remainder of your life.*

A few weeks later, on August 5, 1863, Nils wrote, saying:

I mentioned in my last letter that the fatherland could not give you occupation adequate to your great activity, and that our hopes of seeing you settled here could scarcely be realized. But the political movements here in the North, and in Europe in general, may possibly change this. The three northern kingdoms, Sweden, Norway, and Denmark (not forgetting Finland) are coming nearer and nearer together in relation to the subject of a mutual defence. Three persons from each of these countries are now to meet and to deliberate as to suitable vessels for naval defence, and consider the subject of iron-clads and the monitor system. The latest intelligence, as to the advantages the United States has derived from the vessels you have constructed, will probably increase the desire to use monitors for the naval defence of the North. In view of these circumstances I have concluded to ask you if you would not find it as interesting, as glorious, and satisfactory to appear as consulting engineer and constructor for the navies of the three kingdoms; for each of the countries, individually, according to their several circumstances, and in general for all three in relation to a general system of defence against a common enemy. Your large experience during the war in America, and the experiments the United States have conducted on so large a scale in the use of iron-clads, would of course be of invaluable service to our States if you would devote your energy, your ability, and your experience to the promotion of Scandinavianism, in reference to a common mutual naval defence. Let me know as soon as possible how you view my proposal. I take it for granted that the people, as well as the governments, of the different countries would be glad to secure your person and your great abilities. The minor engineers in the navy of the several countries are the only ones who would not wish to see you return to your native land and engage in the ser-

* Letter from Baron Nils Ericson to John Ericsson, July 11, 1863.

vice of Scandinavia, as each of these is now, in his way, an important person, and this importance would naturally be diminished were such a man as you to take the lead. But we need a chief to reconcile varying opinions.

There is one thing that I should desire, and that is that you were financially independent; as in your case this would add to your reputation and give a greater significance to your recommendations. I don't mean by this that you should work for nothing. By no means; you ought to be paid well. As I am anxious to have your opinion on my project, write as soon as you can.

As to his financial condition, John was able to satisfy his brother, and he wrote December 27, 1867, saying: "I continue as usual with new mechanical works and new undertakings, without involving my own means though—rich men offer me readily necessary means for a share in the undertaking, without my risking anything myself. Perhaps I am the only engineer whose word is sufficient to make capitalists compete for the advantage of venturing their money on untried inventions. . . . When you are questioned regarding my financial condition you can say that your brother is rich, as his income last year, consisting almost entirely of interest, amounted to 75,000 crowns [something over $20,000], according to the present rate of exchange, but in reality amounting to 100,000. In a word, when I some day decide to go home, my baggage will consist, in addition to other things, of fifty or sixty tunnor of gold."*

The Giant and the Dwarfs; or, John E. and the Little Mariners.

[From a Swedish caricature, February 10, 1867.]

JOHN.—Come here, little boys, and I will show you. What do you say about this model of a gunboat for our coast defence?

THE LITTLE BOYS.—Won't do; too small; . . . too heavy draught; . . . too large guns; . . . too light draught; . . . too large; . . . too small guns; . . . won't do—that's what I say; . . . and I also—because it isn't *our* invention.

JOHN.—Well, little boys, that is at least some reason.

* Old Swedish way of counting money.

For other reasons, however, the proposition to transfer John to Scandinavia was not favorably entertained, and he was at the time in the midst of his arduous labors for furnishing the United States with an iron-clad navy. He was wise, in any event, not to accept such an invitation. Seven years later Mr. Forbes said:

"I have long thought you ought to be supreme dictator and monitor over all of Uncle Sam's machinery; but, if in a moment of sanity you should, by something little short of a miracle, get there, your independent, go-ahead character would make so many enemies among the pigmies that they would bind you down hand and foot, as the Lilliputians did Gulliver, and worry you to death."

This would have been the inevitable result of appointing Ericsson at any time to a position for which he was otherwise beyond all men best fitted.

When Nils Ericsson received his title he altered the spelling of his name and became Baron Ericson. This change gave great offence to John, as is shown by an atrabilious letter such as we find occasional examples of in his correspondence.

NEW YORK, May 20, 1864.

MY DEAR BROTHER: To judge from Count Manderstran's remark, it would appear that he forgets that those he describes as the special favorites of fortune are united only in the sound of their names. It is strange that this change of name, followed by disunion among the relatives, should have created less sensation in Sweden than abroad. My enemies here and in Sweden said, even before I knew anything of the matter, that "the rich Swedish engineer" so disliked the relationship that he called himself Ericson to avoid being taken for a kinsman. I can never forget the unpleasantness caused me by this annulling of relationship. Possibly your wife has had her share in it. If so, she will find some day that the blotted-out letter will cost her children half a million. Of all the blunders and mistakes you have made in respect to your brother, this alteration of the name is the most inexplicable and vain. I consider it a practical gain that you have become a member of the Diet, but your heirs will have occasion to regret that you altered your father's and brother's name.

Tell Carl that when I wrote to him to Paris, I had not received his last letter informing me of his last misfortune in Mexico. Your plan of sending him here you have not well considered. What would he do here? See unpolished luxury and bad morals, and possibly be initiated

in vice? Nothing is to be learned here, and so far as I am concerned, I could not give him an hour a month of my time. I live in my work-room, and must not be disturbed. I have still a whole fleet to construct before I can take a rest.

Your affectionate brother,

J. ERICSSON.

For some years the brothers had not corresponded, and the tone of the letters following a renewal of interrupted intercourse, indicates that John felt that other reasons than excess of occupation could in part account for his brother's seeming neglect of him. The misunderstanding in families resulting from the changes that fortune makes in the relation of those born to an equal estate, and from the foreign alliances of marriage, are unfortunately too common to require explanation. Alienation in this case did not go beyond a surface irritation, and John's letter is to be taken only as an illustration of that habit of thinking aloud in which relatives are privileged to indulge one with another. He was morbidly sensitive on some points, and it was not his habit to conceal his opinions. The conciliatory letter Nils sent in reply was an illustration of his difference of temperament.

Nils had shown his good-will by furnishing the means for educating the son John left behind him when he departed from Sweden in 1826. Now that John was independent in his circumstances, his brother suggested that a repayment for his advances would be of great service in helping him out of some pecuniary difficulties, and a draft for the amount named, 10,-000 crowns, was at once sent by John. In his letter asking for the money, Nils said: "Your son Hjalmar has left the corps of engineers, and is now superintendent of the state railways, is a knight of the orders of Vasa and Nordsjerna [Polar Star], an able and most intelligent man." In another letter acknowledging the receipt of the money sent, dated January 6, 1866, he said further:

Your son Hjalmar is now on his travels abroad for the purpose of studying foreign railways and their equipment. I did not see him before he started, but suppose that the Administration of our extensive railways want a chef for the materials and machinery, and have selected Hjalmar for this important office. I enclose a letter from him to show

you that he now knows that it is to his father, and not to his uncle, that he is indebted for his education. I informed him of the fact after you had paid your debt to me.

Ericsson's son was known as Hjalmar Elworth, though he had been accepted as a member of his father's family in Sweden. There was no direct intercourse between father and son until Hjalmar was forty-eight years old. Then he wrote this letter to his father:

November 22, 1872.

My Dear Father: When I now, at the age of forty-eight, for the first time call you father, it is with a grateful heart for all you have done for me. I have long before this wanted to write to you, and asked Uncle Nils about it, but he did not think I ought to do it, so long as you did not write to me. The reason why I write now is that I have received an essay containing a convincing answer to Pater Secchi's doubts as to the accuracy of the apparatus for measuring the sun heat, which essay was sent from New York on October 26th, and arrived here on my birthday, the 16th of this month. I do not think anybody but you could have sent it, and I look upon it as a letter, though a few written lines from you would naturally have made me happier.

Concerning my present position, I want to tell you that I am director-general of the railways, at a salary of 6,000 crowns. Of this one-quarter goes to a pension fund, life insurance, and taxes, so that about 4,500 remains. This is certainly not much, but my dear little wife manages so well that it is enough for our wants, especially as we have no children. I do not wish to be further promoted, as the chefs are not so well paid as they ought to be, and consequently, nobody but a man who has a private income can accept such a place.

I should like to know of a good construction of snow-ploughs for locomotives. We often have, especially in January and February, heavy snow-storms, and I have introduced a plough for removing the snow after a model I saw during my stay in Austria, 1866. These are very well for drifts of 5–6 feet, but when the snow masses become larger, shovelling is needed, which causes a loss of time. It would be of great interest to me to have some details of the sun motor.

If you would answer this letter and let me know something about you, it would make me very happy.

Hjalmar.

This mingling of sentiment and business shows that Hjalmar was the son of his father. The answer to his letter is not to be found. That it was satisfactory appears from the fact that the correspondence thus opened was continued until

Hjalmar's death, in 1887. In 1876 he was sent by his Government as a Commissioner from Sweden to the Centennial Exposition in Philadelphia. He visited his father and received from him friendly attention, and letters of introduction, carrying him wherever he wished to go. Yet the intercourse seems to have been to some extent formal, for on June 6, 1876, the son wrote:

PHILADELPHIA, June 6, 1876.

MY DEAR FATHER: Next Friday I intend visiting the Schools in New York, and will, therefore, ask you to send Mr. Taylor to me to Everett House, at 9 in the morning. If you would grant me half an hour's interview before my departure in the evening, I should be very thankful, and in that case would you let Mr. Taylor tell me the time when you can receive me?

Your affect. Son,

HJALMAR.

The first letter I have been able to find, addressed by Ericsson to his son, is this:

NEW YORK, July 2, 1876.

MY DEAR HJALMAR: In case you would like to start for the West at once, I enclose a letter of recommendation which undoubtedly will give you an opportunity to see and examine all you want. My letters of recommendation have always given the bearer entrance everywhere.

You know that I, through Taylor, have given a copy of the "Centennial" pamphlet to the correspondent of the *Nyar Daglijt Allehanda.* Your proposed letter to that paper will thus be unnecessary.

With great affection,

J. ERICSSON.

Upon Hjalmar's return to Sweden, his father wrote, November 2, 1877, saying: "My fatherland and all concerning it (allow me to remind you of it) interests me tenfold more than what is going on in America."

Ericsson's correspondence with his son was chiefly devoted to the discussion of his projects for defending Sweden, and for publishing a Swedish translation of his "Contributions to the Centennial Exhibition."

To Hjalmar's suggestion that his father should tone down some of the energetic expressions in this work, Ericsson answered that this proposition "makes me the more content not to have my work published in Sweden. You say one should

be 'mild in words when strong in deeds.' To this I only answer that the hammer is my weapon, and if I had not understood how to handle it rightly, I should long ago have been in the poor-house:" thus quoting the sentiment, if not the words, of his favorite poet:

> Mighty indeed is Thor, young man, when, girding tight
> His Megingjard around his iron loins, he strikes.*

Several of Ericsson's letters to his son are devoted to an expression of his discontent, because one of his relatives would insist upon occupying himself with inventions for which he had no proper training or capacity. Speaking of this young man's infatuation with the idea that a worthless engine he had planned was a great discovery, Ericsson said: "He seems to have been bitten by a mad engine constructor." Of the design for a self-counting machine, sent to him by a young Swedish engineer, he said: "This is a very ingenious invention; too ingenious, I fear, to make a success. Why did he not make a self-acting broom? He might then have been a millionaire at the least." When another young inventor showed him a novel plan for propelling a steamboat, he dryly remarked: "It is possible that the wheels may make a few revolutions with this machine, but the boat would certainly go better without any machinery at all."

To his young kinsman, Ericsson absolutely forbade the further introduction of the subject of that invention. As some consolation for the loss of prospective fortune supposed to follow his refusal to assist in developing it, he agreed to honor for one year the young man's monthly draft for five hundred francs, on the single condition that he should not be further called upon to demonstrate the laws of dynamics to his unwilling listener. This anecdote illustrates a characteristic of Ericsson which often gave him an undeserved reputation for brusqueness and unkindness. The assertion of a false mechanical conclusion jarred upon his nerves as a false note upon the musical ear of an expert, or an inharmonious blending of colors upon the eye of an artist.

* Tegner's Frithiof Saga. "Megingjard," Thor's belt of strength.

In 1887 came the announcement that Hjalmar was suffering seriously from enlargement of the prostate gland, and suffering still more, as his father believed, from mistaken medical treatment. Ericsson himself suffered for a dozen years with the same disorder, and in connection with it he had studied the human body as he would study a piece of machinery. He was able to describe the exact nature of his son's difficulty, and explained to him how to deal with it. His letter of advice is a condensed medical treatise on the subject, presented in the clearest possible language. It was not heeded, and he wrote again to say: "I could say much more on the subject, but you are, unfortunately, so conceited that advice is useless. You can also be rude to him who gives you advice, for the contents of my letter of August 6th were, as it seems, not important enough to be mentioned. I was not even thanked for my kindness. All of this I complain of from my heart, because the doctor's stupid treatment, which your wisdom approves of, has made a cure seem very distant, if possible at all. Your complaint was originally of a simple mechanical nature, easy to conquer by simple mechanical means. If you had sought my advice in time you would now have been as well and strong as formerly."

This letter shows Ericsson's attitude toward those he sought to aid. His experience, his knowledge, his ability were at their service, and his purse as well, but his treatment of them was imperious. He had unusual capacity for mastering any subject within the range of his observation; he studied it thoroughly; he reached the most positive conclusions concerning it, and he demanded submission to these conclusions as to the authority of an autocrat. His speech was direct, his spirit was kindly, and his disposition most generous, but his experience in matters of sentiment was limited, and he was not one of those "who feels the hearts of all men in his breast, and knows their strength or weakness through his own." To his daughter-in-law he wrote, on hearing of her husband's death:

My Dear Sophie: The account, in your letter of May 25th, concerning Hjalmar's dreadful state, was painful beyond description. I received, therefore, the telegram that afterward came from Baron Ericson with more satisfaction than grief, as death alone could ease your husband's

pains. His constitution was evidently completely destroyed by physicians' ignorance and his own senselessness. The fact is that your husband, who was an unusually strong man, was simply murdered by ignorance.

Please give my thanks to your sister for her clear account of the

Hjalmar Elworth, Son of John Ericsson.

funeral. Grand funerals are objectionable in my opinion, but in this case it was friendship that arranged the unnecessary pomp.

Your affectionate friend,

J. Ericsson.

When Ericsson suffered from his son's disorder he engaged a physician to come in for half an hour each day, for a year, and talk with him. In this way he learned how to take care of

himself. His method in dealing with medical men was to master their knowledge of his particular conditions and then to decide for himself what course of treatment he would follow. He never yielded himself blindly to the guidance of professional advice, as his son had done.

Hjalmar Elworth's death occurred on July 12, 1887. He was a man of ability and solid acquirements, and one whose character commanded confidence and respect. He followed in the footsteps of his father and his uncle, first as a student and then as a *niveleur* on the new canal works at Trollhattan, and finally as a superintendent of construction. In 1850 he was graduated from the Swedish Military Academy, and after five years' further service upon the canal, he was transferred to the work of railway construction, rising finally to the position of superintendent. In noticing his death, a Swedish paper said: "In the deceased the state railway traffic has suffered a great loss; the members of the administration are deprived of an agreeable associate, and his subordinates of a humane chief, and one who was warmly interested in their welfare."

Ericsson had no children by his English wife, *née* Amelia Byam. In a letter to his brother Nils, he said:

December 27, 1867.

As to my family affairs, you can tell the inquisitive that my wife died in London last July. But only to yourself I will add . . . But I have long since forgotten this, as well as many other unpleasant things. My future, and my success in the world, required that I should not be troubled with children or with a wife who had a full right to live with me. Fate, by means of this misalliance, made it possible for me to devote twenty-five years of undivided, undisturbed attention to my profession, and I am grateful to Providence, because if I had lived in what is called a happy marriage, I should not have gone to America.

Ask those acquainted with the matter, why England and France did not take part with the Southern States on April 1, 1862, as was intended, and they will answer you: Because the *Monitor* saved the American Navy from destruction the 9th of March. It was the cannon in the rotary turret at Hampton Roads that tore the fetters from millions of slaves, and afterward made the French abandon Napoleon's project in Mexico. Consequently, I ask, who can dispute that the designer of the *Monitor* has overthrown Napoleon's great plans?

A word about my health in answer to your inquiries. It sounds

incredible, but I am able to work harder now than when I first came to this country. I sleep better, have a better digestion, a stronger arm, and do not suffer from the least indisposition. I ascribe all this to my way of living. I take a three miles' walk every evening before going to bed, a cold bath and calisthenics every morning before breakfast, and very seldom take wine or any kind of spirits. That I never use tobacco in any form I think is unnecessary to mention. Address your letters to New York, United States. My old house in Franklin Street disappeared several years ago.

As a copy of this letter has been carefully preserved among Ericsson's papers, the inference would seem to be that he intended that the facts it records should at some time be revealed. Consideration for the living prompts the present omission of a portion of it. It is sufficient to say that it explains his peculiar relations to his wife, and shows that it was no waywardness of fancy that led him aside from the quiet paths of domestic life, and into the ways of solitude—" the nurse of enthusiasm, and enthusiasm is the true parent of genius."

Nils responded with sympathy and affection to John's exhibition of brotherly confidence. In a long letter sent in reply to the letter here quoted, he said : " Naturally the care for your own would draw you early into the sphere of daily concerns. As it is, you have been perfectly free, and able to devote yourself exclusively to occupations producing results that astonish the world ; not only because of the genius displayed, but even more for the practical results accomplished. America was the country best suited to your activities, but you probably would never have gone there had your marriage been a happy one. . . . No one in your own country fails to understand that your *Monitor* at Hampton Roads not only turned the scale in the American War, but determined the relations of the European powers to North America."

With the family of his English wife, Ericsson maintained the pleasantest relations up to the time of his death, especially with her niece, the wife of General Sir Trevor Chute, of the British service, and with the brother of Lady Chute, Mr. S. B. Browning, of Auckland, New Zealand.

Mrs. Ericsson's family were persons of character and refinement, and her husband's feelings toward them were shown in a

letter written in 1870, in which he says: "I cherish the remembrance of my sisters with the warmest feelings of friendship and affection. Indeed, they are the dearest friends I have left in England." Speaking of the recent death of his wife's half-sister, one of Mrs. Ericsson's relatives wrote, saying: "I need scarcely remind you of the great regard—I may say affection—Miss Browning entertained toward you. She was never tired of talking about your talent and wonderful inventions."

One of Ericsson's letters to Lady Chute, dated March 16, 1877, shows that even at seventy-four he was not altogether removed from the vanities of this world, and that he could be most gallant on occasion. In this he said:

> I am delighted to learn that you have been presented at court, and note particularly that a sister of the Earl of Dudley introduced you to the Queen. As probably Lady Dudley was present during the ceremony, you had need of all your charms on the occasion, for a friend of mine, who is well posted, tells me that she is considered the handsomest woman in England—now do not be offended—I ought to have said, was so considered *before* the fair stranger from the southern hemisphere appeared in the court galaxy. Pray send for a photographer before you disrobe after having attended the drawing-room referred to in your letter. Accept my warmest thanks for your invitation to visit Egmount Bracknell.
>
> Within a few weeks I shall have the pleasure of forwarding a somewhat stylish book enclosing a record of my principal works carried out on American soil. I trust that a mere glance at its illustrations will convince you that my claim of having carried into practice a greater number of novel ideas than any other person, past or present, is well founded.

His mind was so occupied with his work that he seldom wrote a letter without some allusion to it. In a letter of sympathy to Lady Chute for the loss of friends killed in India, he encloses a cut of the *Destroyer*—as one might be supposed to bestow a toy upon an afflicted child to still its cries. "He gave his best, could do no more." In another letter he sends a picture of his sun motor, and acknowledges the receipt of the portrait he had asked for with this delicate bit of compliment: "I have also before me your portrait, a real treasure—a rare combination of intelligence, power, and beauty. Were it a *drawing*, I should be inclined to think it had been overdrawn, but being a photograph it must reflect that which happily exists."

CHAPTER XXXIII.

PUBLIC AND PRIVATE BENEFACTIONS.

A Yearly Income of 70,000 crowns.—How it was Expended.—The Faithful Steward.—An Affectionate Son.—The Swedish Relatives.—Correspondence with Them.—Opposition to Early Marriages.—Generosity Toward His Kinsmen and Friends.—Public Benefactions.—Desires to be Buried in Swedish Soil.—Jemtland Memories.—Contributions for the Starving Swedes.—Sympathy with Distress and Poverty.—The Blessings of the Poor.—Attitude toward Sturdy Beggars.—Discourages Swedish Emigration.—Romances of Youth.—Nobody's Advice Accepted.—Recognition of Favors Received.—Treatment of Penny-a-liners.—An Example and a Warning.

IN a letter to the son of Nils, written June 13, 1871, Ericsson said :

My income is now limited to about 70,000 crowns [$19,000] a year, as I no longer engage in any mechanical speculations. I live on the interest of my capital, and this amounts to about a million crowns [$270,000]. I own, besides some small property here of no great value, only about 150,000 crowns, except portable property. As to my capital, nothing can induce me to touch a cent of that, for I have a great dread of being poor in my old age. At present I enjoy perfect health. My investigations concerning the power of the sun, which now have aroused the attention of the whole world, absorb a good deal of this interest on my money, and my pensioners take the rest."

In a letter written a year earlier, to a relative who made a call upon his bounty, we have this information :

I am no longer doing any business, but am now living on the interest of my capital. I have made use of the help of my fellow-men in executing my large undertakings, and many of those who assisted me, not having my strong constitution, are tottering with age, and not able to provide for themselves and their families. If I were to consider mere legal obligations, they have no claim upon me, but a just man should be governed by a larger sense of right. My note-book contains

not only a list of such obligations, but a pension list of those before whom gratitude bows its head. Considered with these, how trifling is your claim. But you must not conclude from this that I have forgotten you. On the contrary, I have arranged it so that at my death you will all enjoy a moderate income. Allow me to remark that, as I, myself, have worked from twelve to fourteen hours daily for fifty years, and still continue working, I cannot imagine how anybody can feel happy without full and useful occupation. It cannot be that one so well brought up can think of leading an idle life. Concerning the use of my income, I will tell you that the greater part of it goes to meet the expenses connected with the execution of my great projects for benefiting coming generations. "What have you to do with coming generations?" you thoughtlessly ask me. My answer is, that Providence has, for certain wise purposes, given me greater abilities to use within certain limits than to any other mortal, and I will be a faithful steward.

I now send a check for one thousand francs, promising for the future to send a like sum every six months. I tell you candidly that this money will always be sent by me with the greatest pleasure, and I hope you will accept it with the same feeling.

This last statement was by way of apology for not sending the full sum asked for from the rich American relative.

Until his mother's death, Ericsson's intercourse with his Swedish relatives was chiefly through correspondence with her. He was a most affectionate son, and his check-book shows how ready he was to give substantial proof of his loving interest in his mother's comfort. When nothing else could tempt him from his drawing-board, he would turn aside long enough to answer an inquiry coming from home. The surviving relatives in Sweden during the closing years of his life were, besides his son Hjalmar Elworth, the children and grandchildren of his brother Nils, and of his sister Caroline, the wife of Professor Odner. Nils had three sons, and a daughter who had married Count Axel Mörner, a member of the Swedish Diet. Two of Nils's sons were, with their father, also members of the Diet; the eldest, John, the inheritor of his father's title of Baron, and Werner, the second son. Both of these also held commissions in the Army and took part in the Schleswig-Holstein war, to assist the Danes in their efforts to prevent the transfer of this province to Prussia. The youngest son, Carl, after service as a lieutenant in the Vestgöta regiment and as an officer on the staff of King Charles XV., distinguished himself under Mar-

shal Bazaine in Mexico, carrying home with him to Sweden the scars of active service in the field.

To his sister in Sweden, Mrs. Odner, Ericsson gave a comfortable home, and the proceeds of his caloric patent in that country, amounting to a very considerable yearly income. "Such a good brother as you," wrote the grateful sister, "is not to be found in the whole world." On August 16, 1870, he wrote to Mrs. Odner's daughter, saying: "It is with the deepest sorrow that I learn that your mother is not expected to live. Give her the best love of her affectionate brother, who now seeks consolation in your assurance that sister is calm and resigned to the will of God. From a letter from John, received at the same time with yours, I learn with great joy that there are hopes that brother Nils will be restored to health. God be with you all." A few weeks later, on October 25, 1870, Captain Ericsson, in a letter to his nephew John, said: "The news that I no longer have a brother was indeed a severe blow; it pained me all the more as I had received only a fortnight before the information that my sister had been laid in her grave. The thought of their sufferings presents itself constantly to me, and is in the highest degree painful."

To his sister's daughter he said: "Tell me candidly what seems best to you for the future, and I will do what I can to assist you. Let me know what sum you would like me to give you every six months." He gave directions that the money received from the caloric engine patent should be devoted to the education of his sister's grandchildren, and in addition made an allowance of 3,000 francs to her unmarried daughters.

Letters to his nieces followed at intervals during the succeeding years. With one goes the announcement that "Uncle John" makes the young people happy with the gift of a piano, and nearly all the other letters accompany presents or semi-annual remittance to sweeten the advice or criticism he sometimes gave, and "for which small thanks is still the market price." Having in mind, perhaps, his own experience in early youth, "Uncle John" expresses his regret that a nephew and niece were engaged to be married at too early an age, saying: "The custom of early betrothals, followed by a change of mind resulting from altered circumstances, and new acquaintance,

prevails in my dear country now as formerly." "Early marriages," he sagely says in another letter, "bring large families and great trouble." Writing to his niece concerning her *fiancé*, he said :

"I can well imagine that it is 'hard,' as you say, to be separated so long from your intended, but there is one cure for the pain that follows longing, and that is useful occupation. As I take it for granted that you use the needle with the same skill as the pen, I enclose a check for £30. Buy with the money what is necessary for your house of such things as require to be worked with the needle, and while you are stitching time will fly, and before your work is half finished Clas will be back."

To such of his relatives as needed his good offices, his generosity was unceasing during the last twenty years of his life, and he showed the most sympathetic interest in their affairs. The years that divided between him and his early youth in Vermland seem to have disappeared from recollection, and he was once more at home with his kin. To a married niece he writes, asking her to tell him all about her children, their progress in intellectual and bodily development, and sends the "usual half-yearly allowance." To another who is about to be married, he gives a wedding present of 1,500 francs, with warm congratulations on her choice, and a complimentary reference to an essay published by the bridegroom. To a third he says, "I have now before me the pictures of your three sweet children. It has given me pleasure to look at these images of innocence and joy."

To his great-nephew who boasted of his skill as a hunter he wrote: "Allow me to say that hunting as a pastime is inconsistent with a high degree of cultivation, in spite of the fact that so many royal persons love it. The butcher kills the animal instantly, without torture; the hunter generally wounds his victim and leaves it to die in great pain. That a thinking, humane person can find pleasure in such a pastime is incredible. Gymnastics strengthen and develop the body much more than hunting, and take less time."

In 1863 Ericsson received a call for help from an old lady of eighty-three, who in earlier years had been married to his

father's brother, Eric Ericsson, and after Eric's death had remarried and been for a second time widowed. She wrote that she was thus left in very straitened circumstances. This was one of the busiest periods of Ericsson's life, yet he found time for an immediate and cordial response, saying:

MY DEAR AUNT: It moved me deeply to find from your letter of July 30th, which I received, that you have been unjustly treated, and consequently find yourself in distress for money. It is with the greatest pleasure I obey my aunt's demand, and now, to begin with, enclose a check for 300 crowns. Write and tell me how much you need a year, and I will for the future send the amount. Eric Ericsson's former wife must not suffer want.

Your affectionate, J. ERICSSON.

Other letters followed at intervals in the same vein. To a gift of flowers from the grateful old lady, the nephew replied:

MY DEAR AUNT: My heartiest thanks for the Swedish flowers you were kind enough to send me. That the sight of these flowers from my native land recalled many dear recollections, I need not say; and that my eye has not rested on a Swedish flower since I left my beloved Sweden is also the case. I send you now, through Messrs. Tottie & Arfoerson, 300 crowns, which sum I hope you will have before Christmas. My best wishes for a happy Christmas.

Your affectionate, J. ERICSSON.

Again he wrote:

MY DEAR AUNT: I enclose with great pleasure a check for 300 crowns, hoping it will reach you in good health. I find from your letter that you are still attached to life, and don't complain of all the changes. With the best wishes for your welfare during the winter, and that the coming spring will find you in good health, I remain,

Your affectionate,

J. ERICSSON.

I hope when summer comes you will let me hear from you again.

Ericsson's giving was not a mere weak yielding to persuasion, or a good-natured indifference to money. How carefully he considered the necessity for his gifts, and with what excellent judgment he directed them, is shown by his letters.

Besides generous gifts to relatives and friends, he contributed liberally, in the days of his prosperity, to public objects in

Sweden. Out of the first profits of his monitor contracts he sent a thousand crowns, in September, 1862, to aid in the erection of a monument to Charles XII.; the Vesterland poor received five hundred dollars a year later; and soon after, the same amount was bestowed upon the sufferers by the fire at Carlstad, Vermland, where his father, Olof Ericsson, received his education. How prompt he was in his response to requests coming from Sweden is shown by this copy of a cable message, sent February 16, 1886, in reply to a letter from the librarian of the Royal Library, Stockholm.

Letter received—I remit with pleasure fifteen thousand francs to enable you to purchase, for the Royal Library, Baron Djarklus's valuable collection of eight thousand books, besides numerous written documents. Draft to your order for said amount will be forwarded at once.

To the grateful librarian's letter of thanks he answered:

It is very satisfactory to learn that you are pleased with the collection of old books. It is quite enough for me to learn that many of the works were even more interesting than you expected; so no more need be said on this subject. It is with great pleasure I find that certain editors, in Stockholm and elsewhere, have found reason for saying something in my favor, on July 31st [his eighty-third birthday]. It pleases me especially that they know how warmly I love Sweden.

A word as to this. The Secretary of the Military Academy, in a letter to me, acknowledging the receipt of certain documents I sent relating to my works, considered it appropriate to say something flattering about my new country. To this I briefly replied that I knew but one fatherland, and that I would rather that my ashes reposed under a heap of gravel there, than beneath the stateliest monument in this country.

When Baron John Ericson was transferred to Östersund as the Governor of the Swedish province of Jemtland—where his uncle had passed his youthful career as an officer of the Swedish army—and of the province of Herjedalen, he wrote:

In Jemtland your memory is still cherished. I think I have been told in fifty different places in the province: "Your uncle has lived here," and not to disappoint them I never express my doubts. They have also shown me a number of little things as having belonged to you, and if they all had been your property, you would have needed all the different lodgings.

Relics of John Ericsson were among the choicest of Swedish possessions. August 22, 1864, Count von Rosen wrote that the Royal Library had made application for some treasures in his possession; Ericsson's appointment as lieutenant, his resignation as captain, the only copy of his canal drawings, his green uniform plumes, and some papers. "Your dear face," his sister wrote, "is seen on cigar-boxes, candy, and mosaic cards, among other celebrities."

In answer to an application from his nephew for a likeness, Ericsson said: "There is no portrait of me in America, but there is one in the Patent Museum in London, painted from life by the late renowned American artist, Elliot. I think there is also a copy of it in England, but I am not sure of it. I send here the copy of the only true likeness of me. This photograph was taken some years ago, but I am so little changed that all my friends say that it still resembles me. It is necessary to remark that my hair and whiskers are dark brown, thanks to the progress art has made in our time. Nothing can now induce me to have my likeness taken."

When, in 1867, a terrible famine afflicted parts of Sweden, Ericsson's generosity was without stint. Contributions were solicited from all countries, and out of a total of nearly half a million crowns, the gifts from the United States amounted to $5,620. Of this Ericsson gave all but the odd twenty dollars, promptly sending a draft for £1,120, or 20,216 Swedish crowns. It was no perfunctory gift; his heart went with it. A Swedish traveller, who visited him at this time, tells how his voice choked, and tears filled his eyes, as he spoke of the distress in his native land in tones that thrilled the listener. "It was like an orator electric with inspiration, or a volcano seething with internal fires." With wise forethought he stipulated that his gift should be devoted to the purchase of barley seed for distribution among the poor farmers of Norrland, choosing this as the grain best adapted to their soil and other conditions. "In case the sum should not be sufficient to pay the freight," he said, in sending his munificent contribution, a fortune in Swedish eyes, "the relief committee is hereby authorized to draw a bill on me at sight to meet the deficiency." He urged that supplies be sent forward without

delay, lest the frozen sea should shut out approach, and added, "Let us not be content with giving assurances that life can be sustained on herbs not intended by nature for the food of human beings. Bags of meal will be more welcome among the unfortunates than good advice as to gathering coral-moss for winter food."

Ericsson had contributed on previous occasions to meet similar but lesser emergencies, and the extent of this disaster touched him profoundly. To an inquiry from Captain Fox as to the famine, he answered, November 25, 1867:

> The famine-stricken provinces are part of Jemtland and Westernorrland, and the whole of Westerbotten and Norrbotten, beginning at the 63d parallel and extending 100 miles beyond the Arctic circle. Throughout the whole of this region, covering an area of more than 50,000 square miles, the crops have entirely failed, the frost having completely destroyed the grain; the wretched inhabitants being therefore not only destitute of bread, but of seed for next spring. It must not be inferred from this utter destitution and want that the people of Northern Sweden lack thrift, or omit to prepare for bad harvests. The fact is, that the ill-fated region alluded to has suffered from bad harvests six years in succession. Hence, the calamity of a *complete* failure during the *seventh* year has overtaken the people when utterly exhausted by previous efforts to bear up under their misfortune. True to the humane custom of the inhabitants of those inhospitable regions, mutual relief has been given, until now the entire population stand in need of that speedy assistance, without which thousands will perish during the coming winter. Unfortunately, Sweden was never less able to afford the relief called for than at present. The harvest in many of the central provinces has proved almost a failure, while the commerce of the kingdom is in a very unsatisfactory state, in consequence of a succession of indifferent harvests and the rapidly decreasing demands by foreign nations, of the products of the iron mines and the forests, which formerly enriched Sweden.

This contribution to Sweden was only an enlargement of a stream that flowed continuously. The spectacle of distress and poverty was one that always moved the heart of Ericsson. His own wants were simple, and his personal expenditures were less than his benefactions.

It was the standing rule in his house that no one who applied for food should be turned away empty. He would send

into the street for a bare-legged boy, whose appearance attracted his attention on a cold day, and after a pleasant chat direct that the lad be taken to the nearest shop and fitted with shoes and stockings. "Still," as he remarked upon one occasion, "when I was that boy's age I enjoyed running around in the cold, barefooted." To the poor and the friendless, or to the disabled workman who came under his notice, he was always the kind friend and adviser, and his solicitude as to the exhaustion of the coal-supply of the universe never went so far as to lead him to refuse to fill the empty coal-bins of the distressed widows of his neighborhood. The opinion of him entertained by his neighbors was shown during the draft riots of 1863, when a messenger came from the nearest engine-house to say "if the old man had any use for the boys they are at his service." The stalwart Swede, if the occasion had offered, would, without the help of others, have given any reasonable number of rioters occasion to long remember their introduction to him.

It was Ericsson's custom on warm summer days to cross the ferry to the Jersey shore, and wander in the "Elysian Fields" on Hoboken Heights, with his secretary, Mr. Taylor, watching the boats on the Hudson and the moving panorama of life along the water front of a great commercial city. On one occasion he entered into conversation with an old beggar woman, and at its close bestowed upon her the contents of his pocket-book, reserving, at the prudent suggestion of his secretary, just enough to carry him across the ferry. As the recipient of his bounty turned away, Ericsson said to his companion, "I have made one old woman happy for a day at least."

These illustrations of the kindly spirit that controlled his relations to those about him might be indefinitely multiplied. To improve the condition, and increase the happiness, of his fellow-men, in lesser as well as larger matters, was his religion. In the spring of 1863, in the very high tide of his absorption with monitor construction, he was waited upon by a colored man who wished to interest him in a scheme for benefiting the colored race by encouraging emigration to Africa. He called frequently, but Ericsson was never too busy to see him. The humble colored man, on his mission of mercy, found ready entrance through doors double-barred

against those coming to burn the incense of flattery, or whose visits were prompted by mere curiosity.

Frequent applications for aid came from Swedes on this side of the Atlantic, or from those on the other side who wished for advice or assistance to enable them to come here. When he was told that there was a surplus of civil engineers in Sweden, Ericsson answered that this "is no good omen for me, because when they have failed in everything they come to me. It has been so for more than thirty years." He would aid, when he could, petitioners whose circumstances required it, but, as his secretary once wrote: "Although he frequently gives pecuniary assistance to countrymen in distress, he never lends money to them." He had made "advances" to apparently respectable Swedes, "but in every instance had been defrauded of the sums thus generously advanced." When he was asked to aid a Swedish emigration enterprise, his secretary answered, "that he positively and respectfully declined giving aid to any enterprise tending to induce his countrymen to leave their native land, which stands in need of all its sons."

On December 12, 1879, he gives this uncomplimentary expression to his opinion concerning the United States, in a letter to a Swede at Orebro:

I should deem your allusion to your son's "soaga Kropp" quite sufficient to advise you not to send him to a country which breaks down constitutions more rapidly than probably any other, even in cases of persons enjoying comforts, and which, in view of the privations Mr. Jonas inevitably will have to endure, will prove doubly trying. But when I consider that our five hundred universities and technological institutions, which have just come into full activity, are inundating the country with talented young men who have been trained to do *exactly what is here wanted*—young men, sons of the soil, favored by influential relations--I look upon your son's prospects as simply hopeless; more particularly since a great number of those who are favored as stated, cannot now find employment. I have myself been importuned by some of these young men, whose position is really embarrassing, so much so that some have been compelled to enter the naval service as engineers as the only chance of earning bread. I will merely add: America is no longer the field it once was for educated young foreigners who can neither write nor speak the language fluently.

Having during a series of years suffered great inconvenience and loss by this class of persons, in consequence of my delicacy in answering ap-

plications from abroad in the right way, I have lately been compelled to adopt the course of stating frankly, as I now do to you, that I do not receive persons presenting letters of introduction written by parties who act in opposition to my advice.

Pardon my freedom of expression, but I deem it my duty on this occasion to talk plainly, since it appears you are committing a fatal blunder.

Of course, if Mr. Jonas has sufficient means to live here for a year without earning anything, together with means to defray expenses of a return passage, after having been effectually cured of his fascination, then by all means send him on, that he may learn to what depth corruption, dishonesty, selfishness, and meanness can descend.

Again he wrote: "On no account send any youth here. A Swedish engineer has nothing to learn *here*. Confining work, trade fraud, and superficial show are all this country has to offer." There was so little in Ericsson's life at this time of loving association, that his disgust with his surroundings was not unnatural. America was to him the land of stern reality—Sweden the home of romance, and he turned from the unrelieved monotony of a loveless life among his machines and his calculations, to draw refreshment from the hidden fountains of youthful recollections. To a now silver-haired friend of his early days, he wrote:

My Dear Anton: Your very name recalls many dear memories of my youth, and I remember as plainly as if it were but a few hours since the sound reached my ear, the friendly tone with which Sophie Exvale used to address Anton. No sister could have pronounced the name more tenderly, but if I am not mistaken her feelings for you were more than those of a sister. Excuse my long delay in answering your kind letter. Accept my hearty thanks for your trouble in writing so much in detail. You may be sure I read every line with the greatest interest. . . . I hope to see you again in a few years in my native country.

Ever your affectionate friend,

J. Ericsson.

Of this period of his life, Ericsson wrote, March 24, 1876: "I have for a series of years led an eccentric life. I never visit anybody, and never receive visits excepting from a few professional persons. Our scientific men—all my opponents—I never meet. In truth, I may be regarded as a stranger, of

whom everybody has heard, but whom nobody knows personally." He summed himself up in a word when he said to Mr. R. B. Forbes: "My dear Forbes, that I can act like a bear you know better than anyone else of my friends. Hence, if you have anything *good* to show, there is no living man who can give you his opinion in more plain terms than, yours truly, J. E."

Again, he writes to Captain Adlersparre: "As the result of my isolated situation in the world, and the necessity of always being on my guard to escape being crushed by my adversaries, and the many impostors by whom I have been surrounded, I have come to disbelieve what people tell me until I find it fully confirmed. Do not laugh at me now, Captain, when I say that nobody can mislead me. Do not condemn me if I at the same time confess that I am directed by nobody's judgment but my own, and that I never consult anybody and take nobody's advice."

A Swedish writer says: "Ericsson's reserve kept him long unknown, except in a narrow professional circle in the United States. Had he been well known, Frederika Bremer would certainly, in 1850, with her enthusiastic and patriotic disposition, have given a lively sketch of the first engineer of the world. But she makes no mention of him. It was only when the cannon were fired at Hampton Roads that his fame sounded through the world." Mr. E. P. Watson, editor of the New York *Engineer*, speaking from personal knowledge of John Ericsson, said at the time of his death:

So marked was his individuality, and so peculiar was he in many ways, that but few understood him. John Ericsson was a great man in all respects: he was the man of the century in his profession and in some things out of it. He made an appointment with the writer once, and, by the chances of life, we missed the exact hour by five minutes. Ericsson came into the room in a towering rage, and lost two or three minutes more in soundly berating us for wasting his time. He was right, although we did not know it then. Not the least of his characteristics was his love for the exact truth. He related to us once the fact that a certain notorious person, once connected with a nautical paper in this city, called on him and said he had some facts about the monitors which were not to their credit, and he thought it prudent to call on Captain Ericsson and let him see the damage about to be inflicted on him. In

proof of this the penny-a-liner exhibited a slip of printed matter, which he said was the terrible story already set up. In relating this incident Ericsson was a sight to behold. He was like a lion at bay. His voice had tremendous volume at all times, and he was very dramatic both in action and speech. If he was half as decided in the interview with the penny-a-liner as he was in recalling the fact, the poor fellow must have had a very unpleasant time. . . .

The other side of Ericsson's disposition—his liberality to those who did not try to use him, is shown by this incident: A certain person had unconsciously aided him by bearing unsolicited testimony as to the construction of the monitors and their general features. This person was entirely unknown to Ericsson and had never sought his acquaintance. Ericsson sought him, however, and when he called in answer to an appointment, Ericsson expressed his thanks in his characteristic way. He advanced rapidly into the room and grasped the visitor with both hands, saying: "You have done me a very great service, sir—a very great service. I thank you, sir; it is all true what you say, sir. I am glad to make your acquaintance, sir. That is all, sir. Take this, with my compliments." The visitor took "this," which proved to be a large envelope, and retired in good order. Supposing the envelope to contain some information about the monitors, he carelessly opened it on the street, when five fifty-dollar notes slid languidly out on the pavement. This startled the visitor, who thought something was wrong—that Captain Ericsson had, in his haste, got hold of the wrong envelope; that he really meant to give tracings, but had been deceived in the sound of the contents of the envelope, which rattled very much as a tracing confined in an envelope would. Back posted the visitor, and demanded audience with Captain Ericsson again. This was rash on his part, for the Union was in throes at that moment, and Captain Ericsson was working eighteen hours a day. It can be readily seen that he did not have much time to fool away on interviews. Nevertheless, in answer to the request, down he came from the upper regions in a perfect fever of impatience.

"What is the matter now, sir; what is it? Speak, sir, quick!"

The visitor as rapidly as possible told Captain Ericsson his reasons for returning, which were soon cut short by Ericsson saying:

"That is all right, sir; I know it, sir; I have not made any mistake, sir; I do not make mistakes. Nobody shall do me a service but that I shall pay him, sir. Good-morning, sir. I am very busy indeed," and out the visitor went, breathless. This same gift was repeated, minus the interview, some months later.

Countless similar instances could be related of his munificence. Ericsson literally gave away fortunes in his lifetime; his liberality was boundless to those whom he believed friendly to him. Woe unto them who tried to extract money from him on any pretext, or who opposed him.

Concerning the "penny-a-liner" here spoken of, Ericsson wrote the letter that follows to the editor of the newspaper enjoying his services. I give it here simply because it reveals the nature and origin of some of the influences affecting public opinion, at the time when the merits of the monitors were most actively discussed. Against the combined influences of professional prejudice, trade rivalries, and venal criticism, the busy engineer, whose sole thought was for the perfection of his work, found himself at times almost powerless.

NEW YORK, November 2, 1864.

DEAR SIR: Naval reporter —— blackmailed me for some time. On my discontinuing to pay he attacked the monitors and persecuted me with vile slander. In order to put an end to his assaults I advised Mr. —— of the facts, and sent him an extract from my check-book. —— was discharged, and I now learn, to my regret, reports for your journal. The enclosed paragraph, which appears in your columns to-day, is an atrocious falsehood in every particular.

Permit me respectfully to call to your attention the fact that these untrue, damning paragraphs, that have appeared from time to time in the daily papers, written by reporters simply to exact blackmail, have produced deep discouragement with all loyal people. But for the fact that the leading Governments of Europe have had stationed here a number of competent naval officers who have all reported in favor of the turreted iron-clads, our foreign relations would not now stand as well as they do. European officers have often expressed to me their surprise to find that less than half a dozen needy reporters, persons without patriotism or honor, should have succeeded in deceiving the whole world. . . . Personally I care nothing about the abuse of the reporters, but, as I have before stated, our good cause is seriously injured both at home and abroad.

Yours very respectfully,

(Signed) J. ERICSSON.

CHAPTER XXXIV.

FRIENDSHIPS AND CHARACTERISTICS.

Correspondence with Friends.—Answers to Letters Calling for Professional Advice and Autographs.—His Biography by Adlersparre.—A Fuller History Proposed.—Friendship with Ole Bull.—His Love of Music.—Intimate Relations with Cornelius H. Delamater.—Ericsson's Hasty Temper.—His Manly Acknowledgment of Fault.—Warm Regard for Peter Cooper.—Octogenarian Reminiscences.

FRIENDSHIP, as Emerson tells us, "requires more time than poor busy men can usually command." Ericsson's friendships were thus limited, but when once formed they were as enduring as life. He was as true to his friends as he was charitable and forgiving toward those who had done him injustice or positive wrong. Of him, as of all true-hearted men, his friends could say: "I need never meet, or speak, or write to him; we need not reinforce ourselves, or send tokens of remembrance; I rely on him as on myself." His friendships were like the good wine, that grows mellower and richer with time. In a letter to his old friend Sargent he once said (June 30, 1867):

I will not attempt to apologize for my protracted silence, but ask your forgiveness. I freely admit I have been very negligent, but not indifferent, for I can safely say there is not another man on earth for whom I cherish warmer feelings of friendship than for yourself. Nor is there another man who has stronger claims on my gratitude than John O. Sargent. Admitting thus frankly that I have neglected to fulfil what is really very plain duty, I feel bound to say that, had your *interest* been involved, and could my writing have effected anything for your welfare, you would have had a letter at every post. Imperceptibly I have become so perfectly utilitarian that I can do nothing that does not effect some practical good. My passion to be useful has grown apace.

This illustrates the spirit of Ericsson's life. He was full of kindly feeling, and was always ready to stretch forth his hand to those in need of his service, but his absorption in great projects gave him little leisure for those lesser offices of friendship that furnish the small change of social intercourse. Still, what he did was done with his whole heart, and he added to the gift the grace of cheerful giving. In a letter sent August 30, 1878, to the associate of his early manhood, Count A. E. von Rosen, Ericsson said:

It is with indescribable pleasure that I now find that you enjoy better health than when you wrote me the last time, and may this continue long. My health is unchanged, God be praised. Please accept the enclosed 28,000 francs as a friendly gift from

Your affectionate and grateful friend,

J. Ericsson.

P. S.—As I thought you were blind I was so delighted at seeing your well-known hand that I pressed the signature to my lips.

In a previous letter Ericsson had given expression to the admiration he felt for his friend's display of fortitude at the prospect that he might lose his sight. "My grief at your great loss," he added, "finds relief in the recollection of what Milton accomplished after darkness had laid its hands upon his eyes. Is there anyone with the sharpest eyesight who has given mankind such elevated enjoyment as the blind Englishman?"

Innumerable letters breathe a similar spirit of generous regard for those who had a warm place in his heart, or who had done him service. Among his most valued friends in Sweden was Commodore Axel Adlersparre—heretofore referred to by his earlier title of Captain—at one time Assistant Minister of Marine, and a member of the Chamber of Nobles, as Baron Adlersparre. He was a rough, honest-hearted, and frank sailor, unselfishly devoted to the honor and interest of his country, and with so high a sense of obligation that his sincere wish was that nothing might be said over his grave, except that he "had loved and served his friends, his country, and his God less than he could and should have done." In his youth he had served in the United States Navy, and was a shipmate on the corvette *Cyane*, in 1838, '39, '40, of Captain Fox, afterward Assistant

Secretary of the U. S. Navy. Adlersparre, at that time an officer in the Swedish Navy, was a graduate of the Military Academy at Karlsberg. After having availed himself of three years leave of absence, to do a tour of duty as a common sailor on board an American man-of-war, he procured an extension of his leave and continued his voyages in 1842 and 1843, on Lakes Erie, Huron, and Michigan. This shows the quality of the man, for his sacrifice of his position was voluntary, and upon his return home he was given command of a Swedish naval vessel. He was of an excellent family, his father, Count Adlersparre, having been chief among the patriots who established the liberal Swedish Constitution of 1809.

Adlersparre was a warm admirer of Ericsson, and an earnest champion, in the Swedish Diet and elsewhere, of his ideas concerning the defence of Sweden. In 1866 he published in Sweden a work entitled, "John Ericsson and One Hundred of his Inventions." Writing concerning this, Ericsson said in a letter dated November 7, 1865:

> A complete biography of J. E. will be written by a skilled hand, but the work will be so extensive that many years will pass before it will be completed. It will contain a machine atlas showing my principal works in the mechanical department.
>
> You will understand how extensive the work will be when I mention that the cost will exceed $50,000. The Patent Office in England, some time ago, asked for a list of my most important inventions. As I had not time to read through my diary, which now contains over ten thousand pages, still less to read the documents to which the above-mentioned pages are only an index, I was obliged to write down from memory one hundred inventions, to reach at least the same number as the Marquis of Worcester's paper inventions. A copy of this incomplete list I now send in case you would like to add to it the incomplete biography which Headley, without my knowing it, has written. I beg you to let me pay all the expenses. To speak sincerely, Headley's book does me such injustice in respect to my works that I would not like to have it laid before the Swedish public without the enclosed short list of my mechanical works.

The reference in this letter is to a little volume called "The Miner's Boy," in which Mr. J. T. Headley endeavors to do honor to John Ericsson. Ericsson and Adlersparre were in constant correspondence during the latter part of Ericsson's

life, using Swedish usually as the medium of communication. Their letters were chiefly devoted to the discussion of problems of naval defence, and to an interchange of views as to the best means of securing attention to Ericsson's ideas in his native land. The influences assailing him at home were so powerful and persistent that he was at times misled as to the national sentiment toward him. "It pains me," wrote Adlersparre, November 11, 1867, "that you should believe that you are mistrusted or misunderstood by us here. I can assure you that the reverse is the case. You are looked upon here almost in the light of a demi-god. This is the exact truth."

Other friends of Ericsson's youth were also remembered, and letters from them were ever welcome and most cordially acknowledged. To one of the pretty girls of his boyish recollections, now a distressful grandam, he enclosed 200 francs to defray the expenses of her stay at a water-cure establishment, and continued a yearly remittance until her death, at ninety. "What you say about her age and altered appearance," he wrote to the friend who had called his attention to her wants, "is like an unpleasant dream. It seems but a short time since I saw the beautiful girl, to whose favor all the young men aspired, dancing in the beautiful midnight light of Norrland." When the old lady presumed upon his kindness to ask, through one of his correspondents, that he furnish her with money to pay her debts, Ericsson answered: "For such purposes it is not my custom to be liberal. At Christmas time she may possibly through you receive something to buy candy."

Ericsson was besieged, like all noted men, with requests for his autograph. To the ordinary collector he turned a deaf ear, and it was only on rare occasions that he complied with some special request; then his response was most gracious. To a lady, for example, who asked for a *carte de visite* with autograph, he sent through his friend, John F. Winslow, who proffered the request, a handsomely framed photograph accompanied by his signature. To the innumerable letters that constantly assailed him, asking advice or assistance, pecuniary or otherwise, in bringing out inventions, reply was made according to circumstances. To those who desired him to give his pro-

fessional opinion as to their work, the stereotyped answer was usually sent that Captain Ericsson never gave his opinion on patentable inventions. Too persistent beggars for the favor of his approval would receive a still more positive refusal, adapted to their special form of persistence; for example, a letter from the secretary, saying: "Captain Ericsson declines to have anything to do with your useless invention." On another occasion Ericsson wrote: "As stated, I have abstained from giving an opinion on the plan which you forward. The task of finding fault is a very ungracious one, hence my reticence. To be candid, there is not a redeeming feature in the entire plan, and I sincerely trust such a vessel will never be built." To another correspondent he said: "I regret to find that you are spending your time over a mechanical absurdity." This was followed by an elaborate demonstration of the absurdity.

To R. B. Forbes he thus wrote, concerning the invention of one of his clerical friends:

Pray do not be offended with me for having remained silent during seven days. The fact is I have ceased taking any interest in the mystic ladder, since you inform me that its inventor is foolish enough to think of *foreign patents*. I supposed he was only experimenting as a pleasant pastime, but now that he is bent on making money by his *practically* worthless scheme, I say, as I have said to thousands of other mechanical schemers, that I never investigate or give opinions on inventions intended to be patented. I am truly sorry for your reverend friend, for every dollar he spends on his invention will be lost, not to mention the loss of valuable time which ought to be devoted to the saving of souls.

In some observations on the Patent Laws before the London Society of Arts, in March, 1856, Mr. I. K. Brunel said that, having "all his life been connected with inventions and workmen, he had witnessed the injury, the waste of mind, the waste of time, the excitement of false hopes, the vast waste of money, caused by the Patent Laws; in fact, the evils which generally resulted from the attempt to protect that which did not naturally admit of protection. We were already nearly arrived at that state of things when engineers were almost brought to a dead stand in their attempt to introduce improvements from the excess of protection. He found that he could hardly introduce the slightest improvement into his own ma-

chinery without being stopped by a patent." This was Ericsson's experience. "Like all other original ideas," he wrote, concerning one of his experiences, "entitling me to fortune and honor, the one in question will also be stolen from me."

No man could be more generous than Ericsson in extending kindly advice and assistance to modest merit, where he felt that it was safe for him to do so, without risk of finding some ambitious inventor advertising his approval, after the fashion of patent medicine venders. On one occasion, a young officer of the Engineer Corps of the Navy asked him to recommend an invention he had made. Enclosing a copy of a letter written in response to this, Ericsson said: "I trust that you will derive adequate pecuniary reward for your admirable invention. My wish in this respect is the more earnest since you told me the other day you cared for your mother. Nothing so fully enlists my sympathy as the knowledge that a man is laboring for such a purpose."

Many a young engineer had occasion to remember Ericsson for suggestions and assistance of service to him all through life. Mr. Henry R. Worthington, replying to a letter of thanks received from Ericsson for some service rendered, said (August 20, 1873): "I pray you not to speak of gratitude; I have only to look back to the time when in true kindness you helped me to take my first feeble steps in engineering, to know on which side the debt of gratitude is due. I shall never forget those pleasant and interesting days. Nor shall I ever cease to think of you as one from whom I received nothing but kindness and instruction." In a letter written just before Worthington's death, in 1880, Ericsson said: "In view of the apparently insuperable difficulties overcome, I regard your pumping engine as the greatest achievement in hydraulic engineering of our time."

In 1867, Ole Bull conceived the idea of an improvement in the sounding-board of pianos, and undertook to construct an instrument to illustrate it. He met with no end of difficulties, due to his inexperience, and the fact that he was constantly on the move, giving concerts all over the country. After expending $15,000 on his new piano, he abandoned it and commenced work upon another instrument. The same difficulties

assailed him, or new ones quite as formidable. John Ericsson, learning of his friend's troubles, asked him to explain his idea and agreed to make for him a frame of the right weight and strength, insisting upon one condition only, that it should be accepted as a present.

With this efficient aid, Ole Bull succeeded in completing the second piano to his satisfaction. "No friendly service," says Mrs. Bull in the memoir of her husband, "ever touched Ole Bull more deeply than the generous helpfulness of John Ericsson, whom he admired and loved." Ole Bull himself sent this glowing acknowledgment:

LYSO (BERGEN), September 5, 1877.

GREAT FRIEND: The influence of the last measure of infinite kindness on your part, and the sacrifice of time, money, and benevolent inspiration bestowed upon my humble efforts on so many occasions, is as vivid and present as when they began, and time will be merciful to me that I may realize the more the immense power of your great genius, and subtle influence of your glowing sympathy.

The fiercest animal or spirit from my neighborhood I send to you with warmest greetings; to be trod upon, he will consider the highest honor that ever you bestowed in touching your boots.

The piano improves every day, but much is yet to improve.

Great Master, good Genius, receive the affectionate thanks of

Yours,

OLE BULL.

JOHN ERICSSON, 36 Beach Street, New York.

Speaking of what he called Mr. Bull's "admirable conception of securing the strings of pianos to a separate frame composed of metal, so formed that it may be applied to any wooden stand more or less ornamented," Ericsson said:

It was my privilege often to listen to my lamented friend's disquisitions relating to the violin, showing his clear mechanical conceptions of the laws that govern the construction of that most perfect of all musical instruments. The great violinist possessed a singularly accurate knowledge of the necessary relations between the capability of resisting the tension of the strings, and the elasticity requisite to admit of a perfectly free movement of the sounding-board and other delicate parts of the structure, indispensable to produce those infinitely minute vibrations, the control of which, by his master hands, created tones which enabled Ole Bull to charm his hearers as none of his rivals could. I regard the independent metallic frame for holding the strings of pianos,

as an invention which would do honor to any professional mechanician; and I contemplate with much satisfaction the circumstance that my departed friend entrusted to me the construction of the first specimen of his important improvement.

The relations of the two Norsemen were most affectionate, in spite of the fact that they differed radically on the subject of Scandinavian politics. Ericsson's liveliest sentiment was the love of his native Sweden, and the Norwegian musician, as an evidence of his animosity toward the country which had deprived Norway of her independence, was accustomed to tread the Swedish flag under foot.

In his way, Ericsson was fond of music, and would whistle at his work like a blackbird. No street organ that had a musical note in it could pass his window without calling him from his desk. On one occasion, his attention was arrested by musical sounds. Supposing them to come from some vagrant violinist, he went to his window; no one was to be seen. Suddenly the truth dawned upon him, and with characteristic impetuosity he exclaimed, "My God! it is Ole Bull!" and rushed downstairs, two steps at a time, and into the arms of the great performer, to whom he administered a hearty Norse hug.

Then Ericsson discovered that he was the victim of an amiable little plot. Mrs. Bull, it appears, had sought an introduction, and as Ericsson had never found leisure for this, she had enlisted on her behalf one of his few intimate friends, Mrs. E. H. Stoughton. The two ladies persuaded their husbands to join them in their little scheme, and the quartette went to Ericsson's house. The door was opened by the faithful housekeeper, Ann, who had been carefully trained to stand guard over her master's privacy. Mrs. Stoughton, who was well known to her, hurried the bewildered servant into a back room, where Mr. Stoughton and the two female conspirators hid themselves, while the sweet strains of Ole Bull's violin enticed Ericsson from his seclusion.

Cordial greetings followed the surprise, for Ericsson, when the barriers which surrounded him were once passed, was always found to be a most agreeable gentleman. The ladies left, delighted with the success of their stratagem, and a pleasant acquaintance with Mrs. Bull followed. Of her husband

Ericsson wrote, "So warm a heart and so generous a disposition as his, I have never known." "These words," adds Mrs. Bull in quoting them, "it may be truthfully said, expressed the sentiment and the judgment of the violinist concerning the great engineer."

With his friend "Harry," Mr. Cornelius H. Delamater, Ericsson continued in association for half a century, or from the time of his arrival in this country in 1839, to the death of Mr. Delamater, in 1889. In engineering enterprises they were inseparable, Ericsson furnishing the ideas and plans, and Mr. Delamater the mechanical work and capital for reducing them to practical demonstration. The resources of the manufactory under Mr. Delamater's control were always at Ericsson's disposal, without reference to immediate profit, and the extent of the experimental work is shown by the fact that charges against Ericsson for such expenditures, to the amount of over $260,000, were on one occasion "charged off" on the books of Mr. Delamater's firm; from $15,000 to $20,000 was yearly expended in this way. When there was a loss on such experiments Mr. Delamater usually bore it, Ericsson giving his time and talents. When there was profit, it was divided between them. On the whole, the division was one of which neither had any occasion to complain. Sometimes, as in the case of the *Destroyer*, Ericsson would furnish his full proportion of the outlay, besides his professional labor.

On one occasion, when Mr. Delamater called upon Ericsson in some pecuniary strait, such as all men of business are liable to, he received this answer to his application:

DEAR HARRY: I do not regret—and I am sure you need not—that you called on me to give you a lift in your trouble. Taking my ability for granted, there is not a man on earth you could with more propriety come to. There is, however, abundant cause for regret that my means are at present so limited that I cannot offer a lift worth accepting. The small amount of $50,000 mentioned yesterday is at your service. I am, dear Harry, Yours truly,

J. ERICSSON.

Mr. Delamater's estimate of his friend is shown by this extract from a letter dated Venice, May 6, 1879, addressed to his son-in-law, Mr. George H. Robinson:

I read with great pleasure the April (1879) *Scribner* with the paper "John Ericsson" in it. I suppose I ought to write to Captain Ericsson, congratulating him on the appearance of this paper, but I do not feel like it. Any sketch, like that of Captain Ericsson, is so barren of the real history of my wonderful friend that it is disappointing to me. No one living—or to live—will ever know so well as I, how great in all ways he is, and to me the records which are given are only like grains of sand on the shore—as compared with the real, unwritten history.

Yours truly,

C. H. Delamater.

How well Mr. Delamater understood his friend is shown by another letter in which, after proposing changes in one of Ericsson's plans, he says: "I venture these suggestions with all the diffidence you could wish—shaking in my boots at the idea of, as you once remarked, venturing to teach my father."

Ericsson's hasty temper at times disturbed the harmony of these friendly relations. On one occasion, Mr. Delamater was received in such fashion that he withdrew from Ericsson's presence, registering a vow that he would never call upon him again. Mr. Taylor, Ericsson's secretary, remembering that "blessed are the peace-makers," sought to smoothe over the difficulty between the two, who were, as he knew, still none the less attached to one another. He suggested to Ericsson that possibly the termination of Mr. Delamater's customary visits might be explained by the somewhat uncomplimentary nature of his remarks upon the occasion of the last visit.

"Well," was the answer, "if he wants to be such a fool as to stay away on that account, he can."

Next Mr. Delamater was waited upon and asked why he had not called. "For the very good reason," he answered, "that when I last saw Ericsson he said he did not want to see my d—d old face inside his door again."

With diplomatic reserve, Mr. Taylor refrained from mentioning the exact nature of Ericsson's remark on this subject, but he assured Mr. Delamater very truthfully, that his friend was anxious to see him. He consented to call, and when his familiar knock was heard on the door of Ericsson's room, a hearty voice responded—"Come in, Harry!" Next followed a cordial handshake, and nothing was said on the subject of differences.

On the occasion of another difficulty between them, Ericsson wrote, in response to a note received from his friend:

Let me call your attention to the fact that you have no right to abuse a man for being angry, since anger is involuntary; but you have a right to hold him to strict accountability for all he says, although laboring under excitement, however great.

Nothing in my vehement expression can be construed into an insult to you. If permitted to follow my inclination, this will be the last word on this subject, by writing or verbally. Your letter is all I desire, and all the more satisfactory because it came so quickly after the occurrence —what might have been expected from a man so generous as yourself. Your letter is burning before me and, please God, the occurrence shall be forgotten. Should it ever involuntarily present itself, it will be like that hideous dream which has no reality.

Your truest friend,

J. ERICSSON.

It was thus that John Ericsson would wish to be judged: it is right that he should be thus judged. There was no malice, no unkindness in his heart, and he was always a true and generous friend. The vehemence of his disposition was beyond his control—the necessary accompaniment of the ardent and impulsive temperament which furnished motive power to his rare intellectual ability. Explosive force is the expression of power, and those who deal with imprisoned energies must take their risks. Does not Philip Hone, in his "Diary," tell us of seeing from his front window, one morning, the gentle-hearted poet, Bryant, attacking a fellow-editor and striking him "over the head with a cowskin?" "Those who knew him only in his later years," says Bryant's friend and biographer, Mr. John Bigelow, "would scarcely believe that he had been endowed by nature with a very quick and passionate temper. He never entirely overcame it." Nor did Ericsson; but Thomas Fuller, the pious author of "Holy and Perfect State," assures us that "anger is one of the sinews of the soul."

Whenever Ericsson felt that his impetuosity had carried him too far, he was quick to offer his apologies, and sometimes when the occasion did not require it. On January 4, 1886, General Nelson A. Miles, of the Army, called with Thomas Nast, the artist. General Miles had exhibited an intelligent

and patriotic interest in Ericsson's schemes for national defence, and the great engineer was thus tempted to talk more freely than was his wont concerning the cavalier treatment his propositions had received at Washington. Neither of his visitors was at all disturbed by what was said, but Ericsson felt that he had been too outspoken and on the succeeding day each gentleman received a letter of apology. To General Miles Ericsson wrote, saying:

> I have just sent a note to Mr. Nast, thanking him for his friendly visit yesterday, and apologizing for my rude, not to say profane, criticism of certain high officials in Washington; my excuse being the smarting under the infliction of gross injustice, by which I am frequently thrown off my balance. Pray accept yourself this excuse for my unpardonable rudeness.

To another gentleman, with whom he had engaged in a somewhat animated discussion on an engineering question, he wrote:

> Pray pardon my rudeness during our argument. The fact is, I was quite unwell, a circumstance which I ought to have adverted to at the time. Pray also pardon my having caused you loss of valuable time during an argument which I have no reason to be proud of.

Ericsson was at this time an octogenarian, but whatever the excuses others might make for the infirmities of age, he claimed no privileges for himself. He was sometimes tempted to speak freely of persons who interfered with him, but would afterward show his regret at thus giving way to feeling, and as a rule he refrained from criticising individuals.

Peter Cooper, so long as he lived, was one of Ericsson's most welcome visitors. He had the highest respect for Mr. Cooper's personal character, and the warmest sympathy with his work, as he had for all efforts of men to benefit their fellows. There was a further bond of union in Mr. Cooper's interest in mechanical inventions. The first locomotive ever operated in this country was built by him in 1830, the year after the locomotive trial at Rainhill. The inaccessible engineer was never so busy that he could not find time to run

downstairs for a chat with the great philanthropist. The two octogenarians would exchange, in the later years of their intercourse, recollections of the earlier period when they were engaged in kindred studies, and Ericsson would express his appreciation of the wisdom prompting Cooper to bestow his largess during his lifetime.

CHAPTER XXXV.

RELIGIOUS BELIEFS.

Acceptance of the Doctrine of a Creative Intelligence.—The Great Mechanician.—Omniscience Accepted, but not Omnipotence.—Argument as to a Future Existence.—The Goal of Brahma.—Aversion to Funerals.—The Sermon on the Mount.—Hatred of Cant.—Disbelief in Creeds.—Altruistic Principles.—Methods of Work.

TO Ericsson's religious opinions may be applied the saying of Horace:

"He heard the thunder and believed."

The perfection of the machinery that keeps the universe in motion excited his wonder and admiration, and led him logically to the acceptance of the doctrine of a creative intelligence. Nowhere did he find proof that matter has any inherent power to assume forms other than those imposed upon it by mind, and he was satisfied that the universe is the handiwork of One whom he was accustomed to describe as the "Great Mechanician." He not only believed in a Creator, but in one who is omniscient and controlled by benevolent purpose. The doctrine of omnipotence, as it is defined by theology, he could not accept. In the postscript of a letter to Adlersparre, he said:

P. S.—I trust you have not misconstrued the expressions contained in my letter of February 4th. A more grateful being does not live, or one who is more profoundly impressed with the wonders and perfections of organic nature, than the humble scribe. But, while he fully appreciates the beauty of creation, and admits that *supreme wisdom and infinite benevolence* are displayed in everything, he insists that it cannot be said of matter "there was a time when it was not," and he denies the existence of a power that can disturb laws in full force when the universe was chaos. In other words, he denies the power to do impossibilities; create matter out of nothing, or annihilate that which exists.

J. E.

March 6, 1868.

God is the great constructor—the chief mathematician and mechanic, and are not those whose love of useful endeavor leads them to study the laws of the universe he has created better fitted to understand his nature and purposes than those who occupy themselves in constructing artificial systems of philosophy and religion?

The doctrine of immortality Ericsson found difficulty in accepting. With him the body was a machine, and all experience with machinery taught him that when its force was exhausted, or its working parts decayed beyond repair, it fell into ruin and entered upon the process of disintegration, to pass once more through the cycle of change. He did not concern himself with the argument that it is as impossible to reduce matter as spirit to the last analysis—to the final statement of properties. If it be true that both stand upon a like footing, as something cognizable only through phenomena, the phenomena of one were his familiar, everyday acquaintance, while to seek the other he must explore a region foreign to him, and travel in ways over which the mists of speculation hung heavily.

November 24, 1867, Adlersparre wrote, saying: "I am much obliged to you for the short, but too short, biography in your last letter. It was very interesting to learn how you divide your time. But much remains to learn; for instance, about your meals, gymnastics, if you take wine, sleep after dinner, etc. The reply to these and many other questions would be of greatest interest to posterity, and I hope you will answer them when you have time. I collect here in Sweden all possible materials for a future account of your remarkable way through life. In another world we shall have other rôles, and perhaps there you will be a fine aristocrat who will not soil his fingers with India ink, and whose highest degree of happiness will be to do nothing. Who knows?"

To this Ericsson answered as follows, this and many other letters in these volumes being translated from the Swedish:

New York, February 4, 1868.

My Dear Captain: Replies to your questions: To go to bed at 10 o'clock is too early for a person who has finished a substantial meal at 5¼. And that hour is not suitable either for a person who makes calls in the

evening, and afterward takes exercise in the open air to be able to go to bed with a clear head. Relating to the other world, you can judge of my opinion after having read and considered the following:

The condition of matter is essential to existence and on this is founded an important axiom, "complete void reigns in a place when matter is absent," and consequently a life without matter is an inconsistency, an impossibility. To enclose a person in such a way that when he dies (from suffocation) not a single atom can evaporate is very easy. If he be enclosed in gold, the shutting up will continue for thousands of centuries. I suppose you will say, there is nothing impossible to God; to which I answer, that it is not within God's power to act against mechanical laws, most of which do not even admit a *creator*. For instance: with all his power, God cannot make two straight parallel lines meet, however far they are drawn; neither can he make the square of the hypothenuse smaller or larger than the squares contained in the area of the two sides surrounding the rectangle. I need not tell you that innumerable similar axioms existed before creation, and that the creative power is insufficient to overcome laws that are based on such axioms or rather "*ursanningar*" (original truths), if I be allowed to coin such a word, is indisputable. You can make the application yourself. The desire for continued enjoyment is so strong, especially in those who are selfish by nature, that the final extinction of existence with life, although an indisputable proposition, is one very few have the courage to adopt.

A few weeks later Ericsson wrote:

NEW YORK, April 17, 1868.

MY DEAR CAPTAIN: A word about eternity. Your belief that the soul, which at the most is a mass of wind lacking form and organization, can here "develop" for its great use in the next world amuses me intensely. Is it really a fact that the mechanical mind alone can understand that without thinking machinery thinking is impossible, that remembrance is impossible without an apparatus that receives, keeps, and is able to repeat the impressions, etc.? It would be interesting to know how you think that the poor soul, lacking all these and thousands of other necessary requirements, will be able to get along in another world, if such a one should exist, and if there be in the same some magic apparatus that could carry the shapeless creation through space. As soon as I have time I will give your fine theory such a blow as it cannot resist.

Again he wrote, four days later: "Do not judge too severely my last seemingly frivolous letter. The fact is that I sometimes lack patience to argue seriously against a thesis

which is not supported by *a single truth*, but is contradicted by a thousand facts."

The promised blow was never delivered, for meanwhile Captain Adlersparre lost his wife, and Ericsson, with characteristic kindness, wrote, saying:

NEW YORK, May 29, 1868.

MY DEAR CAPTAIN: It is with great sympathy I find that you have suffered an irreparable loss. Your belief in a life after this, with the comforting idea of the meeting on the other side of the grave, will furnish abundant compensation for the present grief and pain, and give you a consolation which in such cases is denied to the professors of materialism. As I find from your last letter that you really have a firm belief, I will beg your pardon for my remarks about religion. I am never accustomed to say anything on this question when I communicate with one who possesses a settled belief.

In 1879 Ericsson sent this communication to his life-long and most intimate of friends, Cornelius H. Delamater:

DEAR HARRY: Life is the greatest of evils—annihilation the highest bliss. To extinguish individuality in absorption, to close the circle of metempsychosis, to be finally rid of being, is the goal of Brahma's believers, and of,

My dear Harry, Yours very truly,

J. ERICSSON.

The purpose of this letter can only be conjectured. That it has more than ordinary significance is shown by the fact that its destination was carefully concealed from those about Ericsson. The body of the copy retained is in the handwriting of his secretary; the address, the signature and the inscription at the end were written by Ericsson himself and he has appended to the letter this memorandum:

"Forwarded September 16, 1879—Letter put into the lamppost by Louis."

In 1866 Professor Mapes died and Ericsson felt called upon to express to the widow his regret at this loss. How kind and sympathetic he could be under such circumstances is shown by the letter to Mrs. Mapes that follows. It is one of several similar letters written on like occasions, all expressing the liveli-

est appreciation of the loss suffered by the one to whom he wrote:

NEW YORK, January 12, 1866.

MY DEAR MRS. MAPES: I cannot refrain from condoling with you on the irreparable loss which you have sustained. Judging by my own feelings of sadness, I can realize the depths of your sorrow. I always regarded your departed husband as one of the kindest and most generous men I have ever met. These amiable qualities, in connection with his remarkable intellectual powers and accomplishments, impelled me to seek his friendship more than a quarter of a century ago. I now regard that friendship as one of the warmest I ever had the pleasure to form. Never for a moment did it flag. James J. Mapes was always to me the same—true as steel—and I shall ever cherish his memory with affection and esteem. Peace and honor to his ashes. I beg of you to remember me kindly to your bereaved family and am, my dear Mrs. Mapes,

Yours very truly,

J. ERICSSON.

Though Ericsson had been designated as one of Professor Mapes's pall-bearers he did not even attend his funeral. For some reason he had a profound distaste for such services and was never present at a funeral after he left Sweden.

The Sermon on the Mount awakened in Ericsson the deepest admiration, and he was accustomed to refer to it as the most sublime of discourses. To a friend who had become involved in a dispute with some relative he wrote, saying:

I have read your letter of the 23d very carefully, amazed at its belligerent spirit. I say again: seek reconciliation. *You*, with your splendid record and your years, can afford to be magnanimous—not so with your relative. The Founder of the sublime Christian code of morals commands you to ignore the fact that you have been wronged when you meet your adversary. I need say no more.

I regard your reference to "cow skins" as a mere slip of the pen; for I feel confident that *reason*, not resentment, guides in your dealings with those who have offended you.

On one occasion a young naval officer who was threatened with discipline by the Navy Department, because of some indiscretion in which Ericsson's household was involved, appealed

through his father to the sympathies of Ericsson and elicited from him this letter addressed to Secretary Welles:

Mr. —— has requested me in the most urgent manner to address you in favor of his son, who recently insulted some of the females of my household. I cannot imagine how the young man is to benefit by my compliance, and I have so stated to Mr. ——, yet as he persists in his request I have most respectfully to say that as a Christian I cheerfully and completely forgive the insult which young —— has indirectly subjected me to.

This was certainly a practical application of his own teaching.

In a different vein is this letter, addressed to Mr. R. B. Forbes, when the writer and recipient of the letter, as the date shows, had both of them passed the age of three score and ten:

NEW YORK, July 5, 1876.

MY DEAR SIR: You have entered forbidden ground. Were you not, owing to your exceeding goodness, the special pet of heaven, your offending hand would have become paralyzed while sketching the sectional representation of a device intended to supersede the work of the Great Mechanician. He devised the *hollow cylinder* as the only means capable of insuring that lightness and strength indispensable to enable his aerial navigators to perform the wondrous feats which we behold. Know then, audacious improver! that a spar framed as you propose, possesses only a fraction of the strength of a *hollow* spar of equal weight and external dimensions.

Concerning atonement for your temerity, I recommend, besides sincere penitence, protracted fasting and prayer.

Yours very truly,

J. ERICSSON.

Ericsson was occasionally made the victim of attempts to bring him to an orthodox frame of mind. How he received such well-meant interference with his liberty of action and belief is shown by this letter:

NEW YORK, August 6, 1887.

MISS ——: Captain Ericsson directs me to inform you that he has worked three hundred and sixty-five days in the year for upward of forty years. During that period he has devoted more time to the study of the benevolent attributes and wonderful works of the Creator and Ruler of the universe than you have spent within the walls of religious

houses. Captain Ericsson accepts your imperfect knowledge of the subject as an apology for your impertinence in writing to him as you have done.

Very respectfully,

S. W. Taylor, Secretary.

Though Ericsson had a horror of everything that seemed to him to savor of cant, he was always respectful to sincere belief, as the extracts from his letters here given will show. In his house was set up an altar at which his Catholic servant worshipped without molestation, and when the zealous ladies of a Protestant Sunday-school in the neighborhood sought to entice her daughter from her, the master interfered, insisting that the child should follow her mother's faith until she was of an age to judge for herself. The rector who called one Sunday to urge the claims of the school found the great engineer busied at his drawing-desk, and ventured upon some religious admonitions appropriate to the occasion. He was answered by very pointed inquiries as to his own abstinence from labor on the day of rest, and an argument to show that the circumstances did not alter the cases. To the credit of this divine, be it said, that when later on the body of John Ericsson lay awaiting its burial he hastened to place his church at the disposal of the friends of the dead.

Ericsson must have been baptized into the Lutheran Church, but his nearest approach to religious observances was in his election to honorary membership in the Swedish Church of Gustavus Adolphus, established in New York in 1865, and his selection as one of the trustees of the church. In response to an appeal for his assistance in purchasing the church building in East Twenty-second Street he contributed a thousand dollars, and wrote, November 1, 1865, to say: "It will afford me great pleasure to forward the interests of the Swedish Church in New York. Please, therefore, use my name in the manner you propose. I will also cheerfully contribute means to a reasonable amount in furtherance of your important plan."

His relations to this church as a member do not appear, however, to have gone beyond pleasant responses to occasional applications from the good ladies of the congregation for help in carrying on the various enterprises requiring the issue of

tickets, for which the brethren were expected to find sale. Brother Ericsson was always to be depended upon in this way; and if, as a trustee, he was not very punctual in attendance at board meetings, he was looked to with confidence for advice and assistance when the occasion seemed to demand it. When in 1869 the church suffered the loss of $3,000 by the defalcation of its treasurer, the facts were set before Ericsson as due to him as trustee, "though not acting as such, and as so liberal a contributor to the treasury of the church." A letter sent by him to its pastor will show that Trustee Ericsson had pronounced views on at least one subject of importance in administering the affairs of the church. Through the medium of his secretary, he said:

> Captain Ericsson has received your honored communication of September 7th, and desires me to state in reply, that he cannot see the propriety in asking American citizens to pay the debt incurred by the Swedish congregation of Gustaf Adolph's Church. You need not be informed that it is the invariable rule in the United States that congregations who undertake to build, or purchase, churches must depend on their own resources. Obviously, other denominations of different creed cannot, under any circumstances whatever, be called upon to defray your expenses in the manner you propose. Captain Ericsson, under such circumstances, desires to express emphatically his disinclination to second the course you have decided to pursue in regard to the debt incurred by the congregation of Gustaf Adolph's Church.

Evidently Captain Ericsson was better informed on engineering matters than as to the custom of American congregations in seeking pecuniary aid beyond their own membership.

Whatever Ericsson did or did not believe found frank expression on necessary occasion, but he never sought to disturb others with his doubts. He certainly did observe most thoroughly the doctrine of "laborare est orare," and he held with Seneca that "the first petition we are to make to Almighty God is for a good conscience, the next for health of mind, and then of body." Disbelief in any life beyond what he saw was with him the stimulus to increased exertion, that he might benefit his race to the utmost of his great ability. Creeds that would bind his benevolent purposes within the limitations of stated methods might be of service to others; they were not

for him. He loved work, not for its own sake solely, but because through its means he was able to serve his fellow men. As his countryman, Swedenborg, would have said: He was "in the love of use for the sake of use."

I have failed of my purpose if I have not shown in this narrative how faithful John Ericsson was to his altruistic belief. It seems impossible that any one man could have accomplished within the compass of a single lifetime what he accomplished; identifying himself in so many ways with the mechanical changes that have separated the Nineteenth Century so widely from all that preceded it, and opened a new world of thought, and interest, and sympathy, until "a mystic band of brotherhood makes all men one" to a degree that shames the past, and stimulates the utmost hopes for the future.

Is it not to the workers rather than to the talkers that we owe these hopeful changes? True, human development is progressive, and all that has been is involved in what is; yet, so far as appears, the mechanical accomplishment of a single century has done more than the preaching of eighteen centuries to destroy insular prejudice, and to bring men together in human sympathy. The practical nature of Ericsson's mind made it impossible for him to accept shadowy impressions for positive beliefs, about which he was free to dogmatize; yet who has done more than he to realize the Christian ideal of a universal brotherhood, to formulate Tennyson's conception of "the parliament of man, the federation of the world?" It is not statecraft, nor even military genius, that has made the United States, for example, a possibility; it is engineering ability. The bonds that hold us in indissoluble unity were forged in the workshops of craftsmen. It is the railroads, the steamboats, and the telegraph that bind the Pacific States to those on the Atlantic shore; the cities on the Gulf to those that border our great lakes. It was the Pacific Railroad that solved the vexed Indian question, and erased from the map the "great American desert," dividing the East from the West; just as the Trans-Caucasian Railroad of Russia has transformed the wastes of central Asia into cotton-fields, and the murderous fanatics of Merv and Bokhara into peaceful subjects of the White Czar.

Ericsson was in the habit of jotting down on odd bits of paper the mechanical suggestions that dropped upon him by the way, and among his manuscripts are numerous memoranda of this sort, with the dates and the hour of the day when the drawing was made, often far in the evening. This subordination to the conditions under which he worked, no doubt explains in a measure his impatience of suggestion, and his absolute insistence upon strict adherence to his drawings. He never seemed to have any curiosity to examine his work after it had left his hands, and never cared to receive a report as to the practical working of his machinery. He declined a request coming from Captain Fox immediately after the *Monitor* and *Merrimac* affair, that he should visit Hampton Roads and inspect his vessel; and he never went aboard the *Destroyer* but once, and then it was in search of his assistant, whose prolonged absence disquieted him.

"Did you ever hear of Napoleon's attending a company drill?" he once answered, when asked why he was not present at the trial of one of his novel pieces of machinery. It was his office to conceive, to plan, to lay out the work; others must execute, and see to the accurate carrying out of his instructions. Still he was quite capable of supervising when necessary, as his attention to the details of work upon the *Princeton* and the original *Monitor* show.

Ericsson's portrait shows that "massive breadth across the lower part of the forehead usually observed in men of eminent constructive skill." He had remarkable capacity for reasoning *a priori* as to the conditions he had to meet in solving a given problem, and providing for these conditions without waiting for the slow processes of experiment to instruct him as to his methods. "The combination of that faculty of the imagination which we call invention, with the experience, the science, and the caution which are the main qualifications of successful engineers," says John Bourne, "is a combination at once rare and precious; and, like the talents of a great general, it may become a power in the state that will influence its future destinies. Henceforth wars will be determined, not so much by a preponderance of muscle, as by a preponderance of brain; and the example of Ericsson shows how much may be done by one

man to overturn existing systems of naval warfare, and to compel all nations to introduce others of greater efficacy."

Until the era of machinery man was dominated by nature, and all of his thoughts, all of his prejudices, all of his aspirations were limited by the narrow range of his experience and by his isolation from the rest of the world. If such men as Ericsson could have taken advantage of the conditions they created, what could they not have accomplished! It is they who have opened the way for Edison and his work; who have trained commercial men and commercial ideas to comprehend the unlimited possibilities of machinery. It is they who have stemmed and turned the tide of the public sentiment that drove Fitch to suicide, that overwhelmed Fulton with ridicule and saddened his life, that discouraged and thwarted the efforts of Oliver Evans. The language that assailed Fulton was, he tells us, "uniformly that of scorn, or sneer, or ridicule. The loud laugh often rose at my expense; the dry jest, the wise calculation of losses and expenditures, the dull but endless repetition of 'Fulton's folly.' Never did a single encouraging remark, or bright hope, or warm wish, cross my path."

Ericsson's experience was similar to this, and he was halted midway in his progress toward success, and had the undeserved stigma of failure put upon enterprises that needed only the favoring breath of popular, or at least of professional, acceptance to secure for them universal approval. There was no possibility of ideal perfection sufficient to secure currency for some of his inventions at the time they were made. The inventor of half a century or more ago—even more than now—was not merely required to construct practicable machines; he was compelled to reorganize opinions, to combat prejudices, to destroy vested interests most tenacious of life, before he could so much as secure for himself a hearing. Particularly was this the case with a man whose ideas ran counter to official predilections, and who presented himself as a disturber of the sacred rights of professional routine.

CHAPTER XXXVI.

THE SUN MOTOR.

Presentation of the Rumford Medals.—Ericsson Begins His Investigations into Solar Radiation.—His Theory as to the Influence of River Currents.—He Invents His Sun Motor.—Its Prospective Influence in Changing the Seat of Empire.—Applies the Solar Engine to Use with Gas.—Profits of this Invention Exceed the $100,000 Spent on Solar Investigation.

MORE was involved in the contest in the American Academy of Arts and Sciences, referred to in Chapter XIV., than the single question of bestowing the Rumford medals upon John Ericsson. The argument was not only for a recognition of his merits, but against an interpretation of the purposes of the founder of the prize, so narrow, that in sixty-six years only one person had, in the opinion of abstract science, been found worthy of its receipt. Following the award to Ericsson in 1862, it was granted in 1863 to Professor Treadwell for his improvement in the manufacture of cannon; to Alvan Clark for his achromatic telescope; in 1869 to George H. Corliss for his steam-engine, and in 1871 to Joseph Harrison for his steam-boilers. Since then it has been given to L. M. Rutherford for improvements in astronomical photography, and to John W. Draper, J. Willard Gibbs, H. A. Rowland, and S. P. Langley, for their several researches in radiant energy, thermo-dynamics, light, and heat.

The storm aroused by the contest over Ericsson seems to have been followed by a ground-swell of discontent, for there was a noticeable departure in his case from the courteous custom attending the transfer of the gold and silver medals to the custody of the recipient. It is usual to distinguish the occasion with an address before the assembled members of the Academy, and to listen to a response. Possibly Ericsson's absorp-

tion in government work interfered with the usual order. It was certainly made the excuse for a departure from it, and he did not actually receive the prize until four years after he became entitled to it. Finally, in 1866, his chief champion in the Academy, Professor Horsford, took the medals to New York, and a company of gentlemen gathered to witness the ceremony of presentation. Their expectations of listening to a response to Professor Horsford's excellent presentation address were disappointed, however. To Mr. Charles Gould, of New York, who was active in arranging for the meeting, the Rumford presentee wrote, saying :

NEW YORK, May 12, 1866.

DEAR SIR : I have had the honor to receive your very kind invitation, but I regret intensely that you are putting yourself to trouble and incurring expenses on my account, and that a formal presentation of the medals has been arranged, since such a ceremony is wholly repugnant to my ideas and taste. I am practical and utilitarian. I have expressed these sentiments most emphatically to my friend, Mr. Sargent, at whose suggestion Professor Horsford so kindly, and at such an immense sacrifice of time and convenience, procured the medals ; but my friend, it now appears, has not presented the matter to the Professor as he told me he would. Apart from my utter repugnance to the proposed ceremony, I yesterday had the misfortune to hurt my back so seriously as to bring on an old complaint originating in lifting a heavy weight. Many weeks will as usual elapse before I can get out. Please therefore countermand any invitations you may have sent out. My clerk, the bearer of this, will relieve you of all trouble if you only will give him your instructions.

Accept my warmest thanks for your generous intention, and for your kind invitation to the family which I have not.

I am, dear sir, with the highest esteem,

Yours gratefully and truly,

J. ERICSSON.

To Professor Horsford a copy of this letter was sent with this note of explanation :

NEW YORK, May 19, 1866.

MY DEAR SIR : I have your favor kindly inquiring about my health. I am glad to say that I this time got over the effects of my little mishap without trouble—violent movements of the body being all I have to guard against for a short time.

I deem it proper to send you a copy of my letter to Mr. Gould, on the subject of the kindly intended ceremony of presentation.

As Sargent has not performed his promise to explain fully that the recipient of your distinguished favors is an eccentric person, whom nothing can induce to appear in public, and who has not been out of his house in five years, I must now plead my own cause, and beg of you to spare me the pain and embarrassment of a formal presentation of the medals which cost you so much trouble and annoyance in obtaining for

Your most grateful and exceedingly obliged,

J. Ericsson.

There were some extremely sensitive fibres in Ericsson's organization, and one of them appears to have been touched in this case. Spontaneous and cordial recognition of his work was always welcome; that given grudgingly he did not value. To Professors Horsford and Treadwell for their warm, and finally successful, advocacy of his title to honor all praise was due, but not to the Academy as a whole, for it had most unwillingly recognized his merits. It would have been much more gratifying to him if Prof. Horsford could have spoken for all of his associates when he said: "I beg to congratulate you upon the honors you have won through a life of research and experiment, devoted to the prosperity and well-being of mankind, in the field contemplated by the illustrious founder of the Rumford premium."

The award of the Rumford prize gave additional zest to studies that had occupied Ericsson's attention more or less from the commencement of his professional career. The development of his "caloric engine" was naturally associated with inquiries as to the nature of solar energy, and the possibility of its direct application to the purposes of human industry. The distractions of a busy life had given little opportunity for independent investigation, but his heart was in this work from the first, and as soon as wealth and leisure were at his disposal he determined upon a systematic inquiry as to the soundness of the current theories concerning the temperature of the sun and the characteristics of solar radiation. He resolved, as he said, to measure for himself "the intensity of that big fire which is hot enough to work engines at a distance of 90,000,000 miles."

He began his investigations as soon as the close of the American War of Secession relieved him from his responsibility to Government. In 1868 he had made sufficient progress

to enable him to write several letters to the Dean of the Philosophical Faculty of the Swedish University of Lund, briefly stating some of his conclusions, and announcing that he had in preparation a work in which they would be more fully set forth. Solar radiation, in its effect upon the evaporation

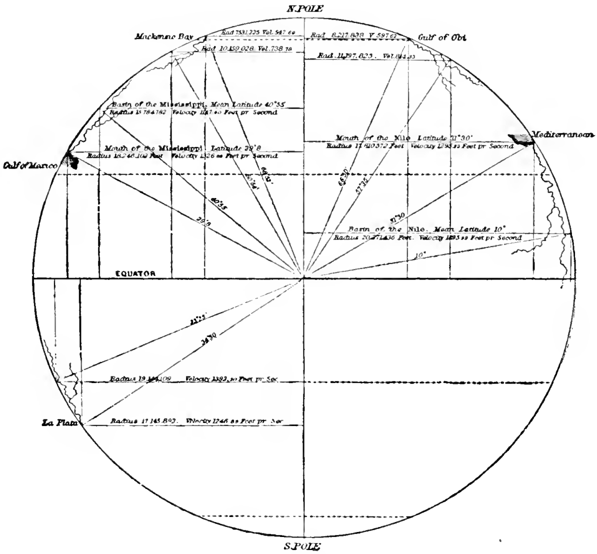


Diagram Showing the Action of the Rivers in Carrying Matter toward the Equator.
Section of the earth represented as a perfect sphere. Mean diameter, 7,912.41 statute miles. Scale, 1,300 miles = 1 inch.

of the waters of the sea had, as he stated in these letters, been with him a subject of investigation for many years.

Abandoning his youthful theories as to the principle of compensation in nature, Ericsson in the end went so far in an opposite direction as to deny the accepted doctrine, that "every imaginable action affecting the rotation of the globe is exactly compensated by the effect of another motion in an opposite direction." The sun so affects the waters of the earth as to

disturb this scheme of compensation, and to an extent sufficient to account for the observed retardation of twelve seconds in a century in the earth's rotary velocity without the influence of the tidal wave, "hitherto greatly overestimated." * It lifts the waters from the seas and deposits them in the channels of great rivers flowing toward the equator. This movement is not compensated for by the vapors traversing the earth's atmosphere in an opposite direction, nor by the movement of the waters in the channels opening toward the poles. Hence there is a tendency to retard the rotation of the earth by heaping up material upon its equatorial circumference; just as the motion of a pendulum is retarded by swinging it through the arc of a larger circle.

Then there is the corresponding movement of the sediment carried along by rivers flowing toward the equator. The Mississippi, with its numerous branches and its thousand lesser tributaries, carries equatorward, to a mean distance of 1,500 miles, and on an average nearly 500 miles farther from the centre of the earth's rotation, a mass of sediment sufficient by its displacement to retard the rotation of the earth .00036 of a second in a century. One hundred and thirty-six rivers flowing toward the equator exert altogether a resisting influence of 72.445 horse-power in each second of time.

The influence of volcanic action in removing matter farther from the centre of the earth was also calculated, and it was shown that the sun rises later than it would do if men had not been busied for so many generations in erecting on the surface of the earth structures composed of materials taken from its depths. Even the concussion of two railroad trains lessens the earth's rotary power by radiating into space a portion of its *vis viva.* The calculated effect of these influences is so infinitesimal that it recalls the Hindoo estimate of the duration of the torments of hell, as measurable by the time required to wear away the rocky range of the Himalayas with a gauze veil

* Ericsson devoted much time to the study of tidal action, hoping to make it available for the production of mechanical power. Speaking of this half a century later, he said, "I had to abandon my various schemes, not being able to compete with the vast energy stored up in lumps of coal. But the time will come when such lumps will be as scarce as diamonds."

brushed against it once in a hundred million years. Still, the result is measurable.

Ericsson's demonstration of this theory is too elaborate and technical to find place here. It resulted in the invention of an apparatus to show that the retarding influence of waters moving in narrow channels from the poles toward the equator is not counterbalanced by the movement in an opposite direction of the same volume of water in the form of vapor.

These interesting speculations were briefly alluded to in Ericsson's communication to the Lund Faculty. He was at that time too busy to enter fully into the subject, and he requested that his letters be considered private. He wrote because he was anxious, as he explained, to show the Philosophical Faculty of the University that other subjects than machine building had occupied his time during the long absence from his native country.

The year in which his communications were sent to Lund completed the second centennial of the opening of the university in 1668. Appropriate ceremonies marked the occasion, and Ericsson received a cordial invitation to attend. This he was compelled to decline, but he sent a thesis on "the use of solar heat as a mechanical motor-power," and received from the university the honorary title of "Philosophiæ Doctor." His thesis was published in a volume of four hundred pages, containing the report of the centennial proceedings.

Ericsson's paper attracted great attention, as it announced the invention of a solar motor intended to supplement the energies of coal in furnishing mechanical power. "I cannot omit," said he in this paper, "adverting to the insignificance of the dynamic energy which the entire exhaustion of our coal fields would produce, compared with the incalculable amount of force at our command, if we avail ourselves of the concentrated heat of the solar rays. Already Englishmen have estimated the near approach of the time when the supply of coal will end, although their mines, so to speak, have just been opened. A couple of thousand years dropped in the ocean of time will completely exhaust the coal fields of Europe, unless, in the meantime, the heat of the sun be employed.

His experiments showed that by concentrating with his ap-

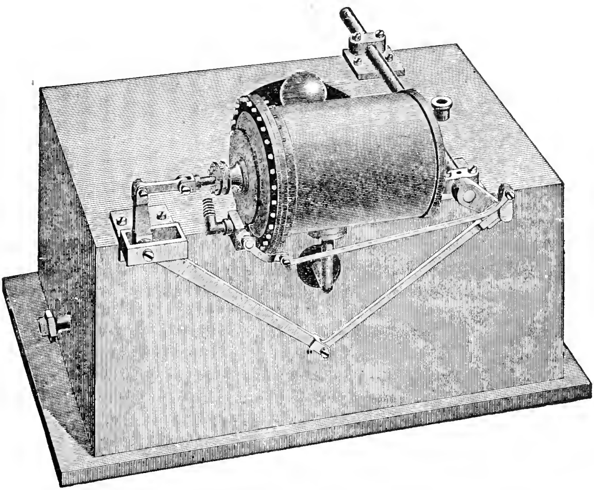
paratus the rays of the sun falling upon a surface ten feet square, he could evaporate four hundred and eighty-nine cubic inches of water in an hour. Of this result, he said: "Its importance cannot be overestimated when we reflect that such an amount of evaporation demonstrates the presence of sufficient heat to develop a force capable of lifting thirty-five thousand pounds one foot high in a minute, thus exceeding one horse-power. As an incontrovertible evidence of the capability of the sun to develop a great amount of heat at high temperatures, this result is probably of greater importance than any other physical truth practically established.

"It is true that the solar heat is often prevented from reaching the earth. On the other hand, the skilful engineer knows many ways of laying up a supply when the sky is clear and the great store-house is open, where the fuel may be obtained free of cost and transportation. At the same time a great portion of our planet enjoys perpetual sunshine. The field therefore awaiting the application of the solar engine is almost beyond computation, while the source of its power is boundless. Who can foresee what influence an inexhaustible motive power will exercise on civilization, and the capability of the earth to supply the wants of our race?"

Ericsson had sought to lessen the enormous waste of coal by his improvements in the steam-engine, and by his substitution of heated air for heated water as a means of converting into motion the imprisoned energies of the coal deposits. He had pleased himself with the fancy that in the "regenerator" of his hot-air engine he had successfully applied nature's supposed principle of compensation; but a new school of philosophy had arisen, declaring with pitiless logic that even in the workshop of the universe itself the expenditure of power was accompanied by waste. This being so he set himself at work to extend at least to eons the period otherwise measurable by centuries, and to awaken to a new life the regions of the earth now parched with solar heat, so that the desert might "blossom abundantly, and rejoice even with joy and singing." The not insignificant amount of one hundred millions of tons of coal had been saved during the last century by using solar radiation in making salt, and still greater economies would result from

even the partial use of solar heat. In the end the world would be forced to depend upon this to supply the energies no longer available from coal fields exhausted by improvident use.

On July 9, 1875, Ericsson wrote that he had up to that time constructed and started seven sun-motors. In the issue of *Nature* for January 3, 1884, he described a sun-motor put into operation the summer before, saying of it: "This mechanical device for utilizing the sun's radiant heat is the result of experi-



Solar Engine Operated by the Intervention of Steam. Built at New York, 1870.

ments conducted through a series of twenty years; a succession of experimental machines of similar general design, but varying in details, having been built during that period."

The first motor was constructed in New York in 1870, and was intended as a present to the French Academy of Sciences. As it was to serve also as a meter for registering the amount of steam generated, friction was reduced to a minimum by making the working parts of unusual dimensions. In the machine as finally perfected the sun's rays were concentrated upon a

cylindrical heater, placed longitudinally above a trough-shaped reflector. An examination of the illustrations will show the difference between the earlier and the later machine. In the first, a surface condenser is concealed in the square pedestal.

Another engine of different construction was designed, and two or three experimental engines were built in 1874. With reference to the application of solar heat to this engine, Ericsson wrote to Mr. Delamater thus enthusiastically:

NEW YORK, October 22, 1873, 18 P.M.

DEAR HARRY: The world moves—I have this day seen a machine actuated by solar heat applied directly to atmospheric air. In less than two minutes after turning the reflector toward the sun the engine was in operation, no adjustment whatever being called for. In five minutes maximum speed was attained, the number of turns being by far too great to admit of being counted.

Having found, by long experience, that *small* caloric engines cannot be made to work without fail, on account of the valves getting out of order, the above solar engine is operated without valves, and is therefore absolutely reliable. As a working model, I claim that it has never been equalled; while on account of its operating by a direct application of the sun's rays it marks an era in the world's mechanical history. You shall see it in good time.

The two-cylinder caloric engine, to be operated by iron whose molecules have been put in violent motion, you will also be invited to see very shortly.

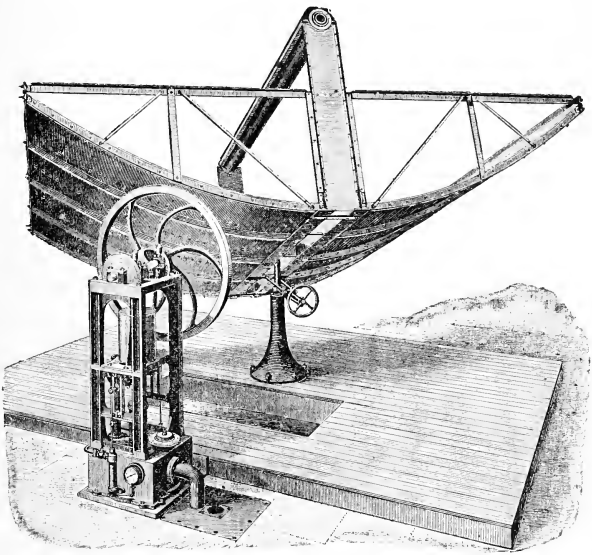
Yours truly,

J. ERICSSON.

The sun-motor required a large reflecting surface to gather sufficient heat from the rays of the sun. To secure this at the least possible expense and in the simplest way, a light frame of wooden staves was made, iron ribs supporting the thin wood. This frame was lined on the inside with flat panes of silvered window glass, set on a curve and held down by the heads of small screws tapped into the ribs of the frame-work.

In France, M. Tellier had undertaken to obtain power by the direct application of solar heat without using reflecting mirrors, but Ericsson used mirrors giving 1,850,000 foot-pounds per hour, with 100 square feet of surface, while Tellier developed only 43,360 foot-pounds per hour, with an exposure of 215 square feet of surface. The solar engine of another French inventor, Mouchot, was condemned after investigation

by the French Government, because his silver-lined curved metallic reflectors were too expensive, could not be made on a scale sufficient to meet the demands of commerce, and became tarnished and ineffective after exposure for a few hours. Ericsson originally used thin metallic plates in his reflector; he subsequently adopted silvered glass, as this was cheap and durable, and it could be cleaned like any mirror with an ordi-



Ericsson's Sun Motor, Erected at New York, 1883.

nary feather-brush. The radiator or reflector was set on a pivot so that it could be revolved and inclined at any desired angle, a pull of five pounds being sufficient to move it.

The practical estimate was ten square feet of reflector for one horse-power. Taking this for a basis, Ericsson said:

Those regions of the earth which suffer from an excess of solar heat will ultimately derive benefits resulting from an unlimited command of

motive power, which will to a great extent compensate for disadvantages hitherto supposed not to be counterbalanced by any good.

There is a rainless region extending from the northwest coast of Africa to Mongolia, nine thousand miles in length, and nearly one thousand miles wide. Besides the North African deserts, this region includes the southern coast of the Mediterranean east of the Gulf of Cabes, Upper Egypt, the eastern and part of the western coast of the Red Sea, part of Syria, the eastern part of the countries watered by the Euphrates and Tigris, Eastern Arabia, the greater part of Persia, the extreme western part of China, Thibet, and, lastly, Mongolia. In the western hemisphere, Lower California, the table-land of Mexico and Guatemala, and the west coast of South America, for a distance of more than two thousand miles, suffer from continuous intense radiant heat.

We learn that 22,300,000 solar engines, each of 100 horse-power, could be kept in constant operation, nine hours a day, by utilizing only that heat which is now wasted on the assumed small fraction of land extending along some of the water-fronts of the sunburnt regions of the earth. Due consideration cannot fail to convince us that the rapid exhaustion of the European coal-fields will soon cause great changes with reference to international relations, in favor of those countries which are in possession of continuous sun-power. Upper Egypt, for instance, will, in the course of a few centuries, derive signal advantage and attain a high political position on account of her perpetual sunshine, and the consequent command of unlimited motive-power. The time will come when Europe must stop her mills for want of coal. Upper Egypt, then, with her never-ceasing sun-power, will invite the European manufacturer to remove his machinery and erect his mills on the firm ground along the sides of the alluvial plain of the Nile, where an amount of motive-power may be obtained many times more than that now employed by all the manufactories of Europe.

Taken in connection with the international compacts of 1890, following the opening of Africa, this statement is full of striking portent. Advancing westward from the ancient East, civilization has conquered Europe; has possessed itself of the American hemisphere, and next, under the lead of the Anglo-American Stanley, is found pressing from all sides upon the still uncontrolled savagery of Africa, perhaps to reveal still grander possibilities of human progress in that undeveloped continent where

The glorious sun
Stays in his course, and plays the alchemist,
Turning with splendor in his precious eye
The meagre cloddy earth to glittering gold.

Stimulated by the labors of Mouchot, Ericsson, and others, William Adams, Deputy Registrar, High Court, Bombay, India, made a series of experiments in that tropical climate with flat mirrors such as Ericsson used. His conclusion was that a combination of such reflectors furnish the only possible means of concentrating solar heat for practical purposes, and that silvered glass is the best, if not the only, available reflecting material.

Archimedes is supposed to have used, in setting fire to the Roman fleet off Syracuse, a combination of the flat steel mirrors then in common use. Buffon, with such a combination of small flat mirrors, set fire to a plank of wood at a distance of one hundred and fifty feet. Concave metallic mirrors, forty-seven inches in diameter, made by Villette, a French artist of Lyons, melted iron ore in twenty-four seconds, cast iron in sixteen seconds, a silver sixpence in seven and one-half seconds, and tin in four seconds. An emerald was melted into a substance like turquoise stone, and a diamond weighing four grains lost seven-eighths of its weight. With a similar mirror Baron Tschirnhausen caused water to boil immediately, and it was soon evaporated. These citations from numerous similar experiments with small reflectors, indicate the possibilities of solar concentration. Mr. Adams gives an interesting account of his own experiments, showing that "there is no limit whatever to the extent to which solar heat can be concentrated by reflection from a combination of flat mirrors." * In a letter to R. B. Forbes, written September 21, 1878, Ericsson said:

> Your scheme of producing fresh water by evaporating sea-water by means of concentrated solar heat is impracticable, on account of the great cost of the needed apparatus. You have probably read the statement of Mr. Adams, of India, that solar heat may be employed as an "auxiliary" in operating steam-engines. The fact is, however, that although the heat is obtained for nothing, so extensive, costly, and complex is the concentration apparatus that *solar steam* is many times more costly than steam produced by burning coal.

To an attempt to store up solar energy Ericsson devoted nearly as much time as to the solar motor, but no satisfactory

* Solar Heat a Substitute for Fuel in Tropical Countries for Heating Steam Boilers and other Purposes. By William Adams, Deputy Registrar, High Court, Bombay. 1878.

result is recorded. The old idea of filling large vessels with compressed air was considered, but this was found wholly inadequate for use on a large scale. Under a clear sky his solar engine performed its functions with perfect uniformity, at a velocity of two hundred and forty revolutions per minute. This engine was moved by steam generated by the heat of the sun.

An illustration in this volume gives a perspective view of another solar engine actuated by heated air. The upper end of the working cylinder is heated by the sun's rays concentrated upon it by a curved mirror. There is a working piston and an exchange piston; one connected with the working-shaft by a beam and a connecting rod; the other by a bell-crank and a connecting rod. A space is left between the exchange piston and the cylinder in which it works. In the passage of the piston downward the cold air from below rushes around it to the upper end heated by the sun's rays. The rapid change in the air thus circulating around the large surface of the exchange piston and the inside of the cylinder, keeps the working piston in motion; the air in the upper end of the cylinder being heated and expanded, and that below cooled and contracted. Thus the exchange piston performs the office of a regenerator. The engine, therefore, is capable of operating for a considerable time by exposing the upper end of the cylinder to the reflected solar heat during a few minutes at starting.

By continuous exposure to the concentrated solar rays, the engine performs fully four hundred turns per minute. Concentrated solar radiation supplies heat with such extraordinary rapidity that the apparently insufficient amount of heating surface presented by the cylinder proved adequate, notwithstanding the great speed of the engine. The body *mm* represents a radiator carrying off the heat which is not taken up by the circulating air during the motion of the exchange-piston.

To Oscar II., King of Sweden and Norway, Ericsson sent, on January 10, 1884, an account of his solar motor, with a pamphlet containing a statement of his opinions as to the best method of defending the harbors of the United States. To the

brief letter accompanying these the King made answer as follows:

ROYAL PALACE OF STOCKHOLM, January 28, 1884.

MY DEAR JOHN ERICSSON: I have read with great interest your letter, for which I thank you most cordially. The description of the apparatus for concentrating solar heat I am not competent to judge of, my knowledge of details being insufficient to form an opinion from the illustration accompanying the letter, but your renowned name is sufficient guarantee of its importance, especially to those countries which suffer from superfluity of radiant heat. I have also perused with the greatest interest the printed document accompanying your letter, which treats the question of the most suitable harbor defence for the United States, and have referred it to the Department of Naval Defence.

It is my heartiest wish that your experiments with the *Destroyer*, the results of which are expected with so much eagerness, may be successful, and that you may find your plans sufficiently matured to enable me to send an officer to you to obtain under your skilled direction, knowledge of all the details of this ingenious war machine.

Expecting further communications from you on this subject, I remain,

Yours most sincerely,

OSCAR.

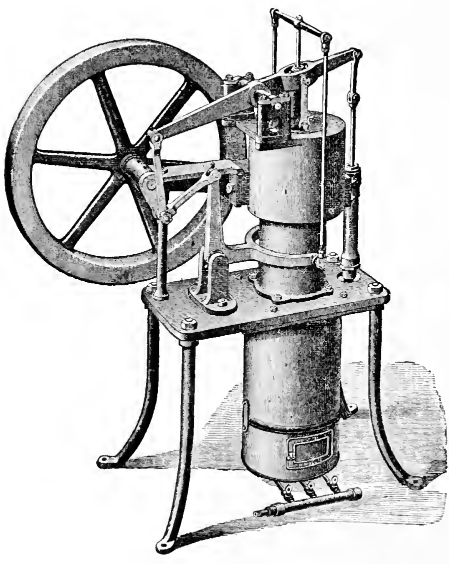
To Mr. James A. Robinson, Ericsson wrote, December 26, 1873, saying:

I omitted to state, when you called to-day, that the successful operation of some of my solar engines in which atmospheric air transmits the energy of the solar heat, some time ago induced me to apply *similar* mechanism to *caloric* engines. I accordingly applied the new movement to a 24-inch caloric engine cylinder and heater. The result was greatly increased speed, but not any gain in actual power developed, as ascertained by the friction-brake. I am not willing, however, to abandon my new scheme, although not longer quite sure of success.

Adapting another form of my solar engine to a small domestic motor, promises better results. I am experimenting with a large model engine which, up to a certain power, has done well. At any rate, it affords me delightful occupation during the hours not devoted to solar observations, torpedoes, amphibic projectiles, monitors, air-compressors, turreted gunboats, cavalry cannon, etc.

The small engine here referred to proved a great success. Its inventor was averse to patenting it, as it formed part of his solar apparatus; and with reference to this he had said in a

published letter dated New York, September 23, 1870, "I shall not apply for any patent rights, and it is my intention to devote the balance of my professional life almost exclusively to its completion. Hence my anxiety to guard against legal obstructions being interposed before perfection of detail shall have been measurably attained." In deference to the request of his business associates, the inventor reluctantly patented its application to the use of hot air, and without solicitation gave the



Solar Engine Adapted to the use of Hot Air. Patented as a Pumping Engine, 1880.

patent right to his business associates of the firm of Delamater & Co. Under their energetic management it was speedily brought into extensive use. Many thousands were sold within a few years, and used for pumping water, and for other light work. The insufficiency of the supply of water has brought them into extensive use in New York City for forcing water

to the tops of tall buildings. The little motor is non-explosive, and so simple in its operation that any servant who can light a lamp or a gas-jet can set it in motion. The profits upon this chip from his workshop are already estimated at several times the amount of the $100,000 expended by Ericsson upon the solar investigations leading up to this invention. Its history furnishes another illustration of the practical nature of John Ericsson's genius, his generosity, and his indifference to money.

Writing to his son Hjalmar, August 13, 1880, Ericsson said, concerning the engine patented: "It is a true copy of the sun-motor when *steam* is not used, the gas taking the place of the concentrated solar heat. It has been so well received here, that Delamater's large works are unable to build as fast as orders are coming in."

With this engine the inventor had his usual experience. An attempt was made to pirate it on the plea that the construction of the experimental engines in 1874 constituted an abandonment of the patent right. In a letter to *Nature* published August 2, 1888, seven months before his death, he said:

It will be proper to mention that the successful trial of the sun-motor attracted the special attention of landowners on the Pacific coast, then in search of power for actuating the machinery needed for irrigating the sunburnt lands. But the mechanical details connected with the concentration at a single point of the power developed by a series of reflectors, was not perfected at that time; nor was the investigation relating to atmospheric diathermancy sufficiently advanced to determine with precision the retardation of the radiant heat caused by increased zenith distance. Consequently no contracts for building sun-motors could then be entered into—a circumstance which greatly discouraged the enterprising Californian agriculturists, prepared to carry out forthwith an extensive system of irrigation. In the meantime, a simple method of concentrating the power of many reflectors at a given point had been perfected, while retardation of solar energy caused by increased zenith distance had been accurately determined, and found to be so inconsiderable that it does not interfere with the development of constant solar power during the eight hours called for.

The new motor being thus perfected, and first-class manufacturing establishments ready to manufacture such machines, owners of the sunburnt lands on the Pacific coast may now with propriety reconsider their grand scheme of irrigation by means of sun-power.

In another letter he said: "You will probably be surprised when I say that the sun-motor is nearer perfection than the steam-engine; but until the coal mines are exhausted its value will not be fully acknowledged. Nevertheless, they will even now use, on the west coast of South America, the new power whose fuel can be obtained without expense or charge for transportation."

CHAPTER XXXVII.

SCIENTIFIC INVESTIGATIONS AND INVENTIONS.

Experimental Apparatus for Solar Studies.—The Centennial Volume.—Measurement of Solar Energy.—Controversy with Father Secchi.—Uncomplimentary Opinion of Tyndall.—Contributions to Scientific Periodicals.—The Lunar Temperature.—Ericsson a Pioneer in Solar Physics.

ERICSSON wrote, November 20, 1868, to two officers of the Royal Society, London, Dr. W. Sharpey and Professor G. G. Stokes, the latter a recipient of the Rumford medal bestowed by the Rumford trust in England. He enclosed an extract from an essay on solar heat, gave some of his conclusions, and said: "Having successfully constructed several experimental engines actuated by the sun's radiant heat, and fully ascertained that motive power, to any extent, can be produced by employing concentrated solar energy, I have determined to investigate fully the subject of solar heat. For this purpose, and in order to facilitate the investigations, I have erected a small observatory over a substantial building some sixty feet above ground. And in order to still further facilitate these investigations, the little observatory is made to revolve round a pivot; while the table that supports the experimental apparatus is kept at a proper inclination by suitable mechanism—hence always perpendicular to the sun during experiments." Professor Joseph Henry, President of the National Academy of Sciences, Washington, was also written to on the same subject.

In an article appearing in *Engineering*, November 27, 1868, Ericsson criticised the conclusion of other observers relative "to the temperature and inconceivable power of the sun to develop heat," as based wholly on the indications furnished by insufficient investigation with imperfect apparatus. He announced the completion of several experimental engines to be

actuated by solar heat, and promised further details of his experiments at a later date. April 7, 1870, he wrote to Professor Joseph Henry again, acknowledging the receipt of an invitation to attend the session of the National Academy of Sciences, and stating that he was obliged to postpone until another year his purpose of submitting a paper. He added:

You will be interested to learn that I have just completed an instrument made to test solar attraction and the earth's density, the principal part of which consists of a solid cast-iron ball eleven inches in diameter, highly polished, floating in a cistern filled with mercury. The ball, which weighs 1,272,060 grains, is readily pulled across the surface of the fluid metal with a force less than $\frac{1}{184000}$ part of the stated weight; the speed during the transit across the cistern being quite perceptible to the eye. Had Maskelyne and James possessed this instrument they would have escaped the troublesome application of the plumb-line, besides obtaining a result freed from the unavoidable errors of astronomical observation in determining the deviation of the line from the vertical.

This reference is to the experiments made nearly one hundred years earlier by Nevil Maskelyne, astronomer royal at Greenwich, to determine the mean density of the earth by measuring the attraction upon the plumb-line of the Scottish mountain of Schiehallion.

On July 15, 1870, Ericsson began the publication of a series of articles appearing in the London periodicals *Engineering* and *Nature*, between July 15, 1870, and February 6, 1873. They averaged nearly one a month, and numbered twenty-nine in all. Six other articles appeared in *Nature* for October 14 and December 9, 1875; January 3 and September 11, 1884; July 15, 1886, and August 2, 1888. These articles furnished the material for thirty-seven of the forty-five chapters of the volume entitled "Contributions to the Centennial Exhibition," published in 1876. The first part of this work is in substance a treatise on radiant heat, solar dynamics, and sun-motors. In the preface the author said: "The commissioners of the Centennial Exhibition having omitted to invite me to exhibit the results of my labors connected with mechanics and physics, a gap in their record of material progress exceeding one-third of a century has been occasioned. I have therefore deemed it proper to publish a statement of my principal labors during

the last third of the century, the achievements of which the promoters of the Centennial Exhibition have called upon the civilized world to recognize."

In 1877, Ericsson wrote to the President of the Italian Royal Academy of Sciences that he proposed to compete for the prize founded by Dr. Bressa, but this purpose was abandoned, and in place of the intended essay two copies of his published volume were sent. The concluding portion of this volume, about one-third in all, is devoted to a description of his principal mechanical inventions during the period of his residence in America, from 1839 to 1876, the date of its publication. The work is a quarto volume of six hundred and sixty-four pages, printed on heavy plate paper, and illustrated by sixty-seven sheets of the very finest specimens of mechanical drawing and engravings. Its author justly prided himself not only upon his skill as a draughtsman, but on his judgment as a critic of mechanical engraving. Some three hundred copies of this book were printed, at an expense of over thirty thousand dollars, and these were distributed to public libraries, to men of scientific reputation, and to a few personal friends. One was sent to the judges of the International Exhibition, Group XXI., and a polite acknowledgment was returned signed by all of the judges. Professor S. P. Langley wrote, September 14, 1877, saying:

> I have, after admiring the book as a rarely complete illustration of what the printer's and engraver's art can do in aiding the exposition of scientific results, been impressed with the value of your work from the purely scientific point of view. The most complete disproof of the trustworthiness of Dulong and Petit's "law;" the vindication of the earlier and discredited generalization of Newton; the convincingly clear statement, for the first time, of what seems to me surely the true means to arrive at the heat received by the earth from the sun (means even now but partly recognized); these, with the conclusions drawn from the great body of most thoroughly considered and carefully executed experiments, bearing on the great subject of radiant solar energy; all form contributions to the sum of human knowledge, of a value which no competent reader can fail to appreciate.

A Swedish edition of the work was projected, and as Ericsson had never acquired facility in the use of scientific termi-

nology in his native language, he entrusted the work of translation to another. The result was not satisfactory, and after the translation was rather more than one-half completed he sent instructions to his son Hjalmar, under whose direction the Swedish edition was preparing, to go no further with it.

Three general theories as to the origin of solar heat have been current. One ascribes it to chemical action or combustion, but Professor Tyndall had shown that this involves the speedy dissipation of the sun into space, and that a mass of coal the size of the sun, which is a body having the specific gravity of coal, would, if supplied with unlimited oxygen, be entirely consumed in six thousand years in producing existing solar energy.

A second theory is that solar heat is the result of friction following the sudden arrest of the motion of showers of meteors, precipitated into the sun with the enormous velocity imparted by the constantly increased attraction. This theory of meteoric showers is met by the calculation that a mass equivalent to that of our moon, must have its motion arrested by the sun and converted into heat to supply working force for a single year; that our earth, precipitated against the sun at the enormous velocity the sun's attraction would create, would furnish heat for less than one century; and with Venus, Mercury, and Mars added, the solar fires of our system could be kept aglow for less than a thousand years—a period counted in the annals of creation "but as yesterday when it is passed, as a watch in the night." Neptune, Uranus, Saturn, and Jupiter might follow in their order, and still only the comparatively insignificant period of 45,558 years would be covered by the entire supply of heat our planetary system could thus furnish.

Rejecting, then, the chemical and meteoric theories, Ericsson accepted, as the ground-work of his investigations, the hypothesis that the sun's heat results from the contraction which was begun when that planet was a nebulous mass of phosphorescent vapor, and is to be continued until Byron's dream of darkness is realized, and the sun becomes "a lump of death, a chaos of hard clay." He estimated that a yearly shrinkage of 124.65 feet is sufficient to account for the enormous energy produced. The solar force expended yearly upon our earth is

equivalent to the power of 217,000,000 thousand horse-power engines, working day and night, but this is a mere drop in the bucket compared with the enormous outpouring of energy. With it all, the yearly reduction in the diameter of the sun is only one ten-thousandth in eighteen hundred and five years, and one-tenth in something over two million years.

The heat emitted by each foot of solar surface will not lessen, Ericsson argued, but as the area of the sun decreases the sum of its energy will diminish accordingly. Tropical intensity on our globe, now estimated at 67.2 degrees, will be reduced in two thousand centuries to 54.4 degrees Fahrenheit; and two million years ago the temperature produced by radiation from the larger sun of that day was 81 degrees. A further demonstration shows "that, although the efficiency of the sun during the past may be measured by hundreds of millions of years, its future efficiency will be of comparatively brief duration," though "the diminution of the temperature produced by solar radiation has not exceeded .027, or $\frac{1}{37}$ degree Fahrenheit since the erection of the Pyramids."

To Professor Langley, Ericsson wrote, January 21, 1877: "I notice that you are very guarded in asserting that the heat transmitted to the earth is actually reduced by sun-spots. On that point I have no doubt, since sun-spots are the result of checked vertical circulation within the solar mass. Any such check must inevitably diminish the heat transferred from the central regions to her solar surface, hence reduced radiation must follow." In a letter to another correspondent he described radiant heat as "mechanical power rendered available when the constant ponderable matter, not perfectly transparent, is presented to its action."

Ericsson's solar investigations, begun in 1864, were continued up to the time of his death. With his rare ingenuity, practically unlimited control of money, and facilities for mechanical construction, he was able to procure whatever apparatus he required. These included twenty-six different machines illustrated in his volume, and others not appearing there; all so elaborate in design and workmanship as to entitle them to the distinction of permanent inventions. These were evolved from scores of ruder contrivances consigned to the

"scrap heap" as soon as they had served their temporary purpose. The perfect instruments were all most beautiful specimens of mechanical art, showing an elaboration in design and an exactitude of adjustment, possible only to a man who had a genius for mechanics, as well as for investigation.

To establish a basis for the measurement of solar intensities it was necessary to ascertain the laws of radiation, by determining what amount of heat was transmitted to a given distance from bodies artificially heated. It was further necessary to inquire to what extent the heat generated by the sun was lessened in its journey over the intervening space of ninety-two millions of miles, and how much of it was absorbed in its passage through our atmosphere. The various instrumentalities for measuring heat were also to be tested, and more exact methods of computation devised, if possible. The patient ingenuity devoted to the construction of the apparatus used by Ericsson has no record in the Patent Office, but it was sufficient to establish any man's reputation as an inventor. On one occasion, two heavily laden wagons carried to a dumping-ground in New Jersey, what appeared to be the débris of a canning factory. These were the shattered remains of the numerous devices out of which had grown his elaborate equipment of solar apparatus, some of the instruments having passed through several dozen transformations before assuming final shape.

Sir Isaac Newton, in estimating the temperature to which the comet of 1680 was subjected when nearest the sun, assumed, as the result of his practical observations, that the maximum temperature produced by solar radiation, in the latitude of London, was one-third that of boiling water, or 60° F. The density of the sun's rays, at the distance of the comet, was 28,000 times greater than on earth, and the sun's heat was increased there in like proportion, or to 1,680,000° F.—exactly 2,000 times that of red-hot iron at a temperature of 840°.

A calculation by Ericsson showed that Newton's estimate indicated a solar intensity of 2,986,000° F. His own estimates varied somewhat, the highest being 4,036,000° F., or 1,373 times that of boiling iron. Estimates by other physicists lie between the extremes of 2,500° and 18,000,000° F.; Vicaire giving the lowest, and Father Secchi the highest.

Ericsson further concluded that the capacity of the sun for emitting heat was relatively less than that of molten cast-iron; "a fact which tends to prove that the sun's radiant heat emanates from burning gases." So Anaxagoras, the instructor of Socrates, was not so far wrong when he affirmed, twenty-five hundred years ago, that the sun was "a cloud enfired."

The solar gases were, as Ericsson's investigations led him to believe, so attenuated that an atmosphere 100,000 miles high, extended over a given area of the sun's surface, would not contain more matter than the terrestrial atmosphere 42 miles high over an equal area, the proportion being as 1 to 152,000. By an elaborate calculation he showed "that the depth of the measurable portion of the solar envelope cannot be less than 255,000 miles, assuming the radius of the sun's body to be 426,000 miles.

Melloni, an Italian physicist who died in 1853, asserted that the amount of heat received from a body transmitting it was in the ratio of the distance, and this doctrine was further elaborated by Professor Tyndall in his "Heat as a Mode of Motion." The numerous experiments described by Ericsson led to the conclusion that this doctrine was unsound, and that it is relative areas, and not relative distances, that determine the degree to which radiating bodies transmit heat. The intervening space, whether it be one mile or 1,000 miles, is to be excluded from the calculation. "The law which governs the transmission of radiant heat through space is as absolute as the law of gravitation, whatever be the distance." The ether offers no resistance to the passage of the sun's rays, and solar heat is diminished by distance only because the rays producing it are dispersed over a greater area, as they proceed further and further from their source.

Hence this conclusion: "*the intensities are inversely as the areas over which the rays are dispersed.*" Yet, it is true that the temperature actually produced by the radiant heat of the sun's rays "is inversely as the square of the distance from his *centre*, the same law applying to all spheres having a uniform temperature at the surface."

Another of Sir Isaac Newton's theories is that the loss of heat by a body is in proportion to the excess of its temperature

over that of the medium surrounding it. The experiments of the Frenchmen, Dulong and Petit, were supposed to contradict this conclusion. To test the question Ericsson constructed several instruments designed to determine the rate at which heat is transferred from or to a body inclosed in a vacuum, and the power or dynamic energy developed by radiant heat. A series of tabulated results are given to show that Newton was right, and that Dulong and Petit were wrong. Hence the theory of an increase of radiant energies at high temperatures was set aside. Twenty seconds were required to produce a change of temperature supposed to occupy, according to the Dulong formula, only the small portion of a single second.

The radiant energy, according to Dulong and Petit, was 1,321 times higher than that established by Ericsson's elaborate practical investigations.

An instrument called the *actinometer*, and various unnamed instruments, were constructed to ascertain, by a new and exact method, the amount of radiant heat absorbed by the atmosphere, and thus to determine the intensity of solar radiation at the surface of the earth. John Frederick Daniell, who founded the English *Quarterly Journal of Science*, and so successfully combined the study of physics with the business of sugar refining that he received the unique reward of all three medals in the gift of the Royal Society, had, in the latitude of London, conducted investigations relative to the sun's heat. Daniell's tables, so frequently referred to in works of meteorology, Ericsson found full of errors, when tested by his actinometer, and he furnishes an entirely different set of data. He discovered, in using this instrument, that there is an appreciable difference in the sun's energy for corresponding distances above the horizon early in the morning and late in the afternoon. This he accounted for by a demonstration showing that "the orbital motion of the earth occasions a very considerable advance toward, and retreat from, the solar wave early A.M. and late P.M."

Not only were the varying zenith distances considered in these observations, but also the varying distances from the sun at different seasons. It resulted from this that solar radiation was less in summer than in winter, owing to the increased distance of the earth from the sun. Sir John Herschel assumed

that the temperature on the earth, if the sun did not exist, would be 239° below zero F., and that the maximum solar temperature is 100° F. above zero. He estimated that the variation, due to the change of distance between the sun and the earth, was one-fifteenth of this difference of 339°, or 23° F. John Ericsson's investigations led to the conclusion that the difference was less than 5° F.

But since the time of Herschel it has been ascertained that we must deduct 460° from the zero of Fahrenheit to reach the point where heat entirely disappears, and "Night and Chaos, ancestors of Nature, hold eternal anarchy." This would increase to 37° F. Herschel's estimate of the variation of one-fifteenth, due to the change in the distance between the earth and the sun $(100+460\div15=37+)$.

The temperature produced by solar radiation, then, instead of being 560° F., as estimated by Herschel, according to Ericsson scarcely reaches 88° F. at a distance of 91,430,000 miles from the solar centre. Recording this conclusion, Ericsson says:

> Concerning the radiant heat which reaches the distant planets of the solar system, the stated discrepancy is of vital importance. Were it true that the intensity of the sun's radiant heat is 560° F. at the distance mentioned, the rays on reaching Jupiter's atmosphere would be capable of developing a temperature of $\frac{560}{5.2^2}=20.7°$ F. We can readily imagine that the atmosphere of the giant planet might, by some system of accumulation, raise this temperature to such a degree that organisms like those of the earth might be sustained. But can the insignificant temperature of $\frac{88}{5^2}=3.2°$ F., transmitted to Jupiter's atmosphere, be sufficiently elevated by the process of accumulation to sustain animate and vegetable organizations resembling those of our planet? The stated low temperature need excite no surprise if we reflect on the fact that the sun, as seen from the boundary of the atmosphere of Jupiter, is no larger than an orange viewed at a distance of one hundred feet. As seen from Saturn, the size of the sun is that of a musket-ball at a distance of fifty feet from the observer's eye; while the transmitted solar heat scarcely develops a temperature of 1° F. where it enters Saturn's atmosphere. Speculations regarding the habitability of the distant planets are futile, in view of the insufficient radiant intensity of solar emission established by the actinometric observations recorded in this work, and by the adopted tests proving their reliability (p. 180).

Following his determination of the amount of solar energy lost by the passage of the sun's rays through our atmosphere, Ericsson next sought to measure the energy actually developed near the earth's surface. For this purpose he constructed two solar calorimeters, one in 1870 and an improvement upon it in 1874. With the two factors of surface heat and atmospheric absorption accurately determined, the amount of solar radiation at the boundary of the terrestrial atmosphere was measured.

The energy developed by radiation from the sun, over one square foot of the earth's surface for one minute, was found to be 5.64 thermal units, and the atmosphere absorbed 0.207. This gave a total of 7.11 thermal units on one foot of surface as the measurement of solar radiation at the boundary of the atmosphere. The investigator was so satisfied with his methods and their results that he confidently said :

> It is not probable that future labors will change the result of our investigation. The continuous shrinking of the sun will produce a perceptible diminution of the radiant energy transmitted to the earth in the course of a few hundred centuries, but the emissive energy for a given area of the sun will remain constant for millions of years, since the intensity developed by the falling mass will increase inversely as the square of its distance from the solar centre, thus balancing the diminution of energy consequent on the reduced fall of the mass (p. 104).

The Jesuit Father Secchi, after his recall to Rome from Georgetown College, D. C., to take charge of the Observatory of the Roman College, undertook a series of investigations into solar physics. The publication of these challenged Ericsson's attention, and he entered upon a lively controversy with Secchi in the scientific periodicals. One point in the contention was as to the amount subtracted from the heat radiated by the sun, during its passage through the solar atmosphere. To determine this, Ericsson constructed a machine of unusual dimension—fifty-eight feet focal length, to measure the amount of heat radiated from different parts of the solar disk. His conclusion was that only 0.144 of the heat starting from the photosphere was subtracted by the solar atmosphere. Father Secchi estimated it at more than sixteen times this, or .88, leaving only $\frac{12}{100}$ of the sun's heat to transverse space.

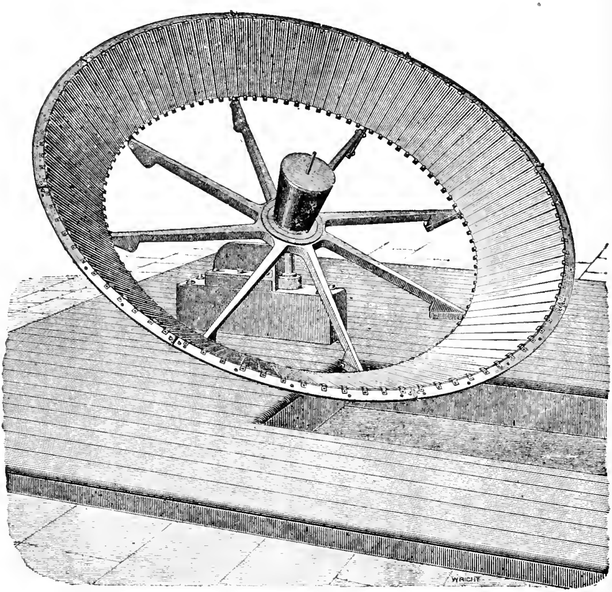
The French mathematician and astronomer Auzout, and his Dutch contemporary Huygens, had, during the latter part of the seventeenth century, sought to measure the intensity of solar light; and the investigations of the Frenchman Bouguer (1698–1758), a few years later, were made use of by Laplace in demonstrating his theory that the light of the sun is greater at the boundary than at its centre, because it is viewed at a lesser angle. Again, on this point, Ericsson took issue with the highest authority and denied the resulting conclusion of Laplace, that the removal of the sun's atmosphere would increase its brilliancy twelve-fold. Absorption of heat meaning the creation of power, Ericsson asks the advocates of the theory of the disappearance of one-half of the sun's heat in the solar atmosphere to account for the enormous energies thus taken up. He adds, too, that the heat is diminished, instead of increased, by being received under the lesser angle. He accepts, however, the conclusion of Laplace, that the sun emits equal energy in all directions, and that the decrease of energy is proportioned to the depth penetrated by the rays.

An elaborate and most interesting demonstration is given to show that a circulatory movement is maintained in the body of the sun, by the gravitation downward of the particles cooled upon the surface, and the upward rush of the more highly heated and thus lighter particles underneath. The uniformity of this interchange is subject to various influences interfering with solar circulation. Of this Ericsson says:

The consequence of this precarious feature of the scheme is self-evident, if we consider that the present solar emission is dependent upon a given rate of contraction of the solar mass. Should that contraction be checked by interrupted circulation, the development of heat will also be checked, and, consequently, the intensity of solar radiation becomes inadequate to sustain animal and vegetable life, as now organized, on our planet. History informs us that the luminary has at certain epochs partially failed to perform its functions. Herschel mentions, in his "Outlines of Astronomy," that "in the annals of the year A.D. 536 the sun is said to have suffered a great diminution of light, which continued fourteen months. From October, A.D. 626, to the following June, a defalcation of light to the extent of one-half is recorded; and in A.D. 1547, during three days, the sun is said to have been so darkened that stars were seen in the daytime." Again, the glacial periods, the ascer-

tained abrupt termination and recurrence of which puzzle the geologist, point to periodical derangement of the solar mechanism in past ages (p. 152).

To show the possibility of accurately measuring the energies of the solar photosphere with his pyrometer, Ericsson cited



Captain Ericsson's Solar Pyrometer, Erected at New York, 1884.

the experience of Cavendish and Baily, who had, by a series of 2,153 most delicate tests, determined the relation between the attractive force, amounting to only $\frac{1}{4300}$ of a grain, exerted by a leaden ball one foot in diameter, and the weight of the sun, 832,584 miles in diameter, the relative attractions of the two spheres being as 1 to $2{,}367 \times 10.^{25}$. As the radiant area of his pyrometer was to that of the sun as 1 to $2{,}871 \times 10.^{16}$,

the two extremes of his equation were 824,500,000 times nearer together than those of the Cavendish experiment. Hence, as he argued, his problem was much the easier of solution.

If investigators differ so widely as to the actual temperature of the sun, they are nearer together in their estimate of solar energy: This is held to represent a dynamic force of about 300,000 thermal units per minute. Ericsson did not believe it possible to develop such energy by radiation from a body having a temperature less than that of boiling iron. He experimented to ascertain the amount of heat transmitted by burning gases; by flat surfaces of metal highly heated, and inclined at different angles, and by globes of metal. Taking his measurements from different points on their surface, and at different angles, he satisfied himself that radiation does not proceed with equal energy in all directions. Increase in the acuteness of the angles correspondingly lessens the energy of the heat-rays, the variation between the extremes being as one to seven. Thus he answered the argument of atmospheric absorption, used by Laplace and others to account for the differences of temperature observed in different portions of the solar surface.

Ericsson intended originally to employ the thermo-electric method, for ascertaining the difference of radiant energy transmitted by the sun's rays from different portions of the solar disk. Though he did not carry out this plan, he made some experimental tests of the correctness of Melloni's assertions concerning the calorific energies imparted to a thermopile, and constructed a special apparatus for calibrating the galvanometer; that is, to ascertain by special measurements, or by comparison with a standard instrument, to what strengths of current particular amounts of deflection correspond. Experiments with this apparatus showed that when the needle of the galvanometer "has moved through an arc of 13 degrees, the energy is greater than the deflection in the ratio of 15.28 to 13.00, instead of being exactly balanced as stated by Melloni."

As Père Secchi in his investigations used an instrument of his own contriving, called a thermoheliometer or sun-heat meter, Ericsson procured one of these from Cellini, of London, subjected it to careful tests, and condemned it as utterly unreliable.

He entered upon an elaborate demonstration to show, too, that no measurements depending upon the bulb indications of a mercurial thermometer were sufficiently accurate for his purpose. The solar rays influencing the mercury in such a bulb are distributed over an area twice as great as their section, thus diminishing their mean intensity one-half. There is also serious loss of heat from the cold currents of air circulating around the half of the bulb not under the sun's rays.

This discovery led him to devise his "barometric actinometer," or instrument for measuring the energy of the sun's heat-rays through changes in the pressure of the atmosphere, which is, indeed, what the thermometer does in a less accurate way. The bulb in this instrument had the general shape of a kettle-drum, with a slightly convex crystal taking the place of the parchment. This hemispherical cup of metal was charged with dry atmospheric air, and placed at the bottom of a cylinder exhausted of air and surrounded by a double casing, so as to secure a uniform temperature within, by the circulation of water around the exterior. A barometric tube was so connected with the dry air in the bulb as to furnish an exact indication of the degree of expansion resulting from the action of the sun's rays transmitted through the glass to this imprisoned air. The amount of heat absorbed by the glass was tested, and other careful corrections of the measurements were made.

The area of the surface of the bulb in this instrument corresponded to that of the pencil of rays acting upon it, and it had only one-half of the surface from which to radiate away the heat it received. Mechanism was attached to enable the operator to direct the tube accurately toward the sun, and to ascertain its distance from the zenith by examining a graduated quadrant. "Meteorologists," said Ericsson, "will do well to adopt such an instrument in all important observations, since its simultaneous indication of solar intensity and zenith distance enables them to determine the relative amount of vapor present in the atmosphere, with a degree of precision probably unobtainable by any other means."

Tests were also made to determine the conductivity of mercury, the conclusion arrived at being that it has so little capacity for transmitting heat from particle to particle, that "thermom-

eters and thermoheliometers with spherical bulbs are worthless as means of measuring maximum intensity of solar radiation." Copper was found to have 29.06 times the conductivity of mercury. Incidentally, the fact was established that a plate of wrought copper two inches thick would conduct from one side to the other one hundred times as much mechanical energy as it could radiate from its surface during the same time.

The "diathermacy" of flames, or the extent to which they permit the passage of heat, as transparent objects permit the passage of light, was another subject engaging Ericsson's attention. To test this a special apparatus was constructed. It consisted of a number of gas-jets so arranged in a row that their heat passed to a thermometer through the flames of other jets. Thus it was found that when one flame transmitted 1.76 degree of heat a given distance, ten flames, owing to the interference of those nearest the thermometer with the free passage of heat from the others, transmitted only 7.90 degrees instead of 17.6 degrees (1.76 × 10), as they should have done theoretically.

As to the sufficiency of Ericsson's experiments, it is said that they do not take account of what Professor Langley, one of the highest authorities on solar physics, speaks of as "the hitherto too little regarded quality of selective absorption in our atmosphere." The absorbent power of the atmosphere varies with different heat-rays, and if the eye were sensitive to these rays they would represent to our sight something analogous to the colors of the prism. The cosmic dust, circulating in space, also plays an important part, according to this authority, in the interception of heat-rays. And Professor Tyndall says: "As the air of a room accommodates itself to the requirements of an orchestra, transmitting each vibration of every pipe and string, so does the interstellar ether accommodate itself to the requirements of light and heat. Its waves mingle in space without disorder, each being endowed with an individuality as indestructible as if it alone had disturbed the universal repose." *

Ericsson had great respect for the opinions of Professor Langley, if he did not accept them. The Professor of Natural

* John Tyndall: Fragments of Science, p. 178.

Philosophy in the Royal Institute was not an authority to whose dicta he bowed. "Tyndall," he said in a private letter, "is a contemptible reasoner, although a splendid lecturer on experimental physics. All his fine writing, if severely scrutinized, will be found to betray a shallow mind. His promise and potency of inert matter is not only absurd, but idiotic."

Whatever the final determination as to the correctness of some of Ericsson's conclusions, it cannot be questioned that he has made very important contributions to science. Among them, is his original demonstration of the fact that "an air thermometer, placed in a concave spherical radiator composed of ice, and surrounded by very cold substances, say 100 degrees below zero, will furnish an indication by which the temperature of distant incandescent bodies may be ascertained with as much certainty as by employing a radiator heated to such a degree as to emit luminous rays." From this it would appear to follow that solar radiation adds a like increment of heat to all bodies, whatever their previous temperature. A lump of ice below 32 degrees in temperature, and a mass of molten metal having a temperature of 3,000° F., each receive the same increase of heat when exposed to the direct rays of the sun.

One experiment would seem conclusively to dispose of the theory of extremely low temperature for the solar photosphere. He constructed a small sun of his own, having a temperature in excess of that ascribed to our central luminary by Pouillet and others. This was a mass of 7,000 pounds of melted cast-iron run into a vessel lined with fire-clay from a cupola furnace, where it had been superheated to over 3,000° F. On the surface of this glowing body of metal was floated a calorimeter to measure the radiant energy. The temperature was sufficiently high to produce an intense white light, luminous rays of great brilliancy were emitted during the experiments, and the heated body was so large that the intensity of radiation was sustained without appreciable diminution. As increase of dimensions does not add to the radiant intensity of a given area, "it may reasonably be asked," says Ericsson, "why an area of one square foot of our experimental luminous radiator should not emit as much heat in a given time

as an equal area of the solar surface, if the temperature of the latter be that assumed by Pouillet?"

Ericsson found in the operation of his sun-motor further proof of the correctness of Newton's theory, that the energy of solar radiation increases as the density of the rays. There could be no increase in the heat of the rays received by his reflector, yet, as the size of the reflector increased and a larger mass of rays was compressed within the area of the heater, its temperature increased correspondingly.

A calculation was made to prove that the temperature imparted to the heater indicated a solar intensity of not less than 1,303,640° F., and this was not the maximum. Those who refused to accept his conclusions admitted that he reasoned logically, and that his experiments were ingenious and novel. The dispute was as to the premises. Ericsson denied that the activity of radiation increased out of proportion to the increase of temperature; Professor Langley and others insisted that this increased activity was so great that the city and county of New York might be warmed by the heat radiated from a single stove if its temperature was sufficiently high.

In September, 1884, Ericsson sent to *Nature* an account of experiments he had just completed with a new apparatus for establishing the relations between diffusion and the energy of solar radiation. This was the "polygonal reflector" composed of two circles. The diameter in the outer circle is eight feet, and of the inner six feet, and the circles are one foot apart. Between them are placed side by side ninety-six strips of thin glass silvered on the outside, furnishing a reflecting surface of 3,130 square inches section. This instrument is turned toward the sun and its rays concentrated on a heater of thin plate-iron 0.017 inch thick, fixed in the centre. Through the tube in the head of this heater a thermometer is inserted to measure the temperature. This instrument was more exact in its indications than the sun-motor, and the conclusion from it was that the temperature of the solar surface could not be less than 3,060,727° F. Ericsson says:

This underrated computation must be accepted, unless it can be shown that the temperature produced by radiant heat is not inversely

as the diffusion of the rays. Physicists who question the existence of such high solar temperature should bear in mind that in consequence of the great attraction of the solar mass, hydrogen on the sun's surface raised to a temperature of 4,000° Centigrade, will be nearly twice as heavy as hydrogen on the surface of the earth at ordinary atmospheric temperatures; and that, owing to the immense depth of the solar atmosphere, its density would be so enormous at the stated low temperature that the observed rapid movements within the solar envelope could not possibly take place. It scarcely needs demonstration to prove that *extreme tenuity* is incompatible with low temperature, and the pressure produced by an atmospheric column probably exceeding 50,000 miles in height, subjected to the sun's powerful attraction, diminished only one-fourth at the stated elevation. These facts warrant the conclusion that the high temperature established by our investigation is requisite to prevent undue density of the solar atmosphere.

It is not intended at present to discuss the necessity of tenuity with reference to the functions of the sun as a radiator; yet it will be proper to observe that, on merely dynamical grounds, the enormous density of the solar envelope which would result from low temperature, presents an unanswerable objection to the assumption of Pouillet, Vicaire, Sainte-Claire Deville, and other eminent *savants*, that the temperature of the solar surface does not reach 3,000 degrees C.

To separate Ericsson's conclusions concerning solar temperature and solar radiation, from the demonstrations leading up to them, is scarcely just. Fortunately, his reputation as a scientific observer does not depend upon this brief biographical statement. In his Centennial volume he has given a very full account of his investigations, and the processes of reasoning establishing his deductions are there shown. As this volume is accessible to very few, it seems due to his reputation that some suggestion of the nature and extent of his scientific work should be given here. A remarkable example of his power of reasoning, and his capacity for clear statement, is found in an article published by *Nature*, July 15, 1886, when Ericsson was just completing his eighty-third year. His study of heat had led him to some novel conclusions concerning what he called "that shining lump of ice, the moon." In his article in *Nature*, this vigorous octogenarian thus wrote:

A monograph by the writer, relating to the temperature of the lunar surface, read before the American Academy of Science, September, 1869, contained the following: "Are we not forced to dissent from Sir John

Herschel's opinion that the heat of the moon's surface, when presented to the sun, much exceeds that of boiling water? Raised to such a high temperature, our satellite, with its feeble attraction, could not possibly be without an envelope of gases of some kind. Indeed, nothing but the assumption of extreme cold offers a satisfactory explanation of the absence of any gaseous envelope round a planetary body which, on account of its near proximity, cannot vary very much from the earth as regards its composition. The supposition that this neighboring body is devoid of water, dried up and sunburnt, will assuredly prove one of the greatest mistakes ever committed by physicists."

This assertion was based on demonstrations showing that the circular walls of the great "ring mountains" on the lunar surface are not, as supposed, composed of "mineral substances originally in a state of fusion." The height and diameter of these walls being recorded in "Der Mond,"* computations based on the safe assumption that the areas of their transverse sections cannot be less than the square of their height, establishes the important fact that the contents of the wall of, for instance, Tycho, the circumference of which is 160 miles, height 2.94 miles, amounts to $2.94 \times 260 = 1{,}382$ cubic miles. The supposed transfer of this enormous mass, in a molten state, a distance of 25 miles from the central vent imagined by Nasmyth, and its exact circular distribution at the stated distance, besides its elevation to a vertical height of nearly three miles, involve, I need not point out, numerous physical impossibilities. Other materials and agencies than those supposed to have produced the "ring mountains" must consequently be sought in explanation of their formation. A rigid application of physical and mechanical principles to the solution of the problem, proves conclusively that water, subjected successively to the action of heat and cold, has produced the circular walls of Tycho. The supposition that these stupendous mounds consist of volcanic materials must accordingly be rejected, and the assumption admitted that they are inert glaciers which have become as permanent as granite mountains by the action of perpetual intense cold.

Independently of the foregoing demonstration, the fallacy of the volcanic hypothesis will be comprehended by its advocates on learning that the quantity of lava requisite to form the circular walls of Tycho would cover the entire surface of England and Wales to a depth of 125 feet.†

Next follows a mathematical demonstration to show that, as the temperature produced by the sun's radiant heat is only 81.11° during the summer solstice, this is the maximum of increase on the lunar surface when presented to the sun while the

* Der Mond; oder allgemeine vergleichende Selenographie.

† Area of England and Wales, 58,320 square miles; contents of the walls of Tycho, 1,382 cubic miles; hence $\frac{1382}{58320} \times 5{,}280 = 125.12$ feet.

earth is farthest from the luminary. Attention is called to the fact that the moderate heat produced by solar radiation is capable of increasing the temperature of bodies previously heated to a high degree. An illustration and description is also given of the pyro-heliometer, an instrument by which this great fact was established. Returning to the subject of the lunar surface and temperature the article continues thus:

Regarding the temperature prevailing during the lunar night, its exact degree is not of vital importance in establishing the glacial hypothesis, since the periodical increment of temperature produced by solar radiation is only a fraction of the permanent loss attending the continuous radiation against space resulting from the absence of a lunar atmosphere; besides, all physicists admit that it is extremely low. Sir John Herschel says of the night temperature of the moon, that it is the keenest severity of frost, far exceeding that of our Polar winters. Proctor says: A cold far exceeding the intensest ever produced in terrestrial experiments must exist over the whole of the unilluminated hemisphere. The author of "Outlines of Astronomy" has also shown that the temperature of space, against which the moon at all times radiates, is —151° C. (— 239.8° F.); Pouillet's estimate being —142° C. (— 223.6° F.). Adopting the latter degree, and allowing 81.11° for the sun's radiant heat, we establish the fact that the temperature of the lunar surface presented to the sun will be 223.6° less 81.1°, or —142.5° F., when the earth is in aphelion. It will be well to bear in mind that when the earth is in the said position, the sun's rays acting on the moon subtend an angle of 31′ 32″, hence the loss of heat by radiation against space will be diminished only 0.000021 during sunshine. Nor should Herschel's investigation be lost sight of, showing that stellar heat bears the same proportion to solar heat as stellar light to solar light. Stellar heat being thus practically inappreciable, the temperature produced by stellar radiation cannot be far from absolute zero—an assumption in harmony with the views of those who have studied the subject of stellar radiation, and consequently regard Pouillet's and Herschel's estimate of the temperature of space as being much too high.

Having disposed of the question of temperature, let us return to the practical consideration of the glacial hypothesis. The formation of annual glaciers by the joint agency of water and the internal heat of a planetary body devoid of an atmosphere and subjected to extreme cold, is readily explained on physical principles. Suppose a sheet of water, or pond, on the moon's surface, covering the same area as the plateau of Tycho, viz., 50 miles diameter and 1,960 square miles. Suppose, also, that the internal heat of the moon is capable of maintaining a moderate steam pressure, say 2 pounds to the square inch, at the surface of the water in the pond. The attraction of the lunar mass being only one-sixth

of terrestrial attraction, while the moon's surface is freed from any atmospheric pressure, it will be evident that under the foregoing conditions a very powerful ebullition and rapid evaporation will take place, and that a dense column of vapor will arise to a considerable height above the boiling water.

It will also be evident that the expansive force within this column at the surface of the water will be so powerful at the stated pressure, that the vapor will be forced beyond the confines of the pond in all directions with great velocity. No vertical current, it should be understood, will be produced, since the altitude of the column, after having adjusted itself to the pressure corresponding with the surface temperature of the water, remains stationary, excepting the movement consequent on condensation from above. The particles of vapor forced beyond the confines of the pond, on being exposed to the surrounding cold caused by obstructed radiation against space, will, of course, crystallize rapidly, and in the form of snow fall in equal quantity round the pond, and hereby build up an annular glacier. As the radius of the vaporous column exceeds twenty-five miles, it will be perceived that, notwithstanding the rapid outward movement before referred to, some of the snow formed by the vapors rising from the boiling pond will fall into the same, to be melted and re-evaporated.

In connection with the foregoing explanation of the formation of annular glaciers, their exact circular form demands special consideration. An examination of Rutherford's large photograph of the lunar surface shows that, apart from the circular form of the walls, the bottoms of the depressions are in numerous cases smooth, rising slightly toward the centre uniformly all round. The precision observable proves clearly the action of formative power of great magnitude. Referring to what has already been explained regarding the vaporous column of twenty-five miles radius, calculation shows that a surface temperature exerting the moderate pressure of two pounds to the square inch will produce an amount of mechanical energy almost incalculable. Practical engineers are aware that the steam rising from a surface of water ten square feet, heated by a very slow fire, is capable of producing an energy of one horse-power; consequently a single square mile of the boiling pond will develop 2,780,000 horse-power. This prodigious energy will obviously be exerted *horizontally*, as the weight of the superincumbent column of vapor balances its *expansive* force precisely as the weight of our atmosphere balances its expansive force. But unlike the earth's atmosphere, which is restrained from horizontal movement by its continuance round the globe, the vapor of the column of fifty miles diameter is free to move beyond the confines of the pond. A very powerful horizontal motion, especially of the lower part of the vaporous mass, will thus be promoted, acting in radial lines from the centre, the principal resistance encountered being the friction against the water.

Considering that the friction against the surface of the ocean, caused by the gentle trade-wind, is sufficient to produce the Gulf Stream, we need no figures to show the effect upon the water in the boiling pond produced by the vaporous mass propelled by an energy of two pounds to the square inch, in radial lines toward its confines. A circular tidal wave of extraordinary power, together with a return under-current toward the centre, will obviously be the result. But agreeably to the laws supposed to govern vortex motion, these currents cannot be maintained in a radial direction. A rotary motion, rapidly augmenting, will take place, producing a vortex more powerful than any imagined by Descartes. The radial currents of the vaporous column having assumed a spiral course, will rapidly acquire a velocity exceeding that of a cyclone. The practical effect of the powerful movement of the vortex, it is reasonable to suppose, will resemble that of a gigantic carving-tool, whose thorough efficiency in removing irregularities has been proved by the exact circular outline presented by thousands of lunar formations. The terraces within the "ring mountains" indicated on Beer and Mädler's chart,* it may be shown, were produced by evaporation resulting from low temperature, and reduced energy after the formation of the main glacier.

There is another feature in the lunar landscape scarcely less remarkable than its circular walls and depressions. In the centre of nearly all of the latter one or more conical hills rise, in some cases several thousand feet high. Has the rotary motion of the boiling vortex any connection with these central cones? A brief explanation will show that the connection is quite intimate. The under-rated estimate that ten square feet of surface under the action of slow fire is capable of developing one horse-power, proves the presence of a dynamic energy exceeding 5,000,000,000 of horse-power at the base of the vaporous column resting on the boiling water of a pond as large as that of Tycho. No part of this power can be exerted vertically, as already explained, on the ground that the weight of the vapor restrains such movement.

The great velocity of the vortex resulting from the expenditure of the stated amount of dynamic energy will of course produce corresponding centrifugal force; hence a maelstrom will be formed capable of draining the central part of the pond, leaving the same dry, unless the water be very deep, in which case the appearance of a dry bottom will be postponed until a certain quantity of water has been transferred to the glacier. It should be observed that the central part of the bottom, freed from water, will also be freed from the surrounding cold by the protection afforded by the vaporous mass. The quantity of snow formed above the centre, at great altitude, will be small, and of course diverged during the fall. Evidently the dry central part, prevented, as shown, from cooling, will soon acquire a high temperature, admitting the for-

* Charte der Gebirge des Mondes.

mation of a vent for the expulsion of lava, called for as the moon, whose entire dry surface is radiating against space, shrinks rapidly under the forced refrigeration attending glacier-formation. Lava cones similar to those of terrestrial volcanoes, and central to the circular walls, may thus be formed, the process being favored by the feebleness of the moon's attraction. The existence of warm springs on the protected central plains is very probable; hence the formation of cones of ice might take place during the last stages of glacier-formation, when those plains no longer receive adequate protection against cold.

In accordance with the views expressed in the monograph read before the American Academy of Science, continued research has confirmed my supposition that the water on the moon bears the same proportion to its mass as the water of the ocean to the terrestrial mass. I have consequently calculated the contents of the circular walls of the "ring mountains" measured and delineated by Beer and Mädler, and find that these walls contain 630,000 cubic miles. The opposite hemisphere of the moon being subjected to similar vicissitudes of heat and cold as the one presented to the earth, the contents of the circular walls not seen cannot vary very much from those recorded in "Der Mond;" hence the total will amount to 1,260,000 cubic miles. Allowing for the difference of specific gravity of ice, the stated amount represents 1,159,000 cubic miles of water. But "Der Mond" does not record any of the minor circular walls which, as shown by the large photograph before referred to, cover the entire surface of some parts of the moon. On careful comparison, it will be found that the contents of the omitted circular formations is so great that an addition of fifty per cent. to the before-stated amount is called for. An addition of twenty-five per cent. for the ice-fields, whose extent is indicated by cracks and optical phenomena, is likewise proper. The sum total of water on the moon, therefore, amounts to 2,028,600 cubic miles.

Adopting Herschel's estimate of the moon's comparative mass, viz., 0.011364, and assuming that the oceans of the earth cover 130,000,000 square miles, it will be seen that the estimated quantity of water on the moon corresponds with a mean depth of 7,250 feet of the terrestrial oceans.*

This depth agrees very nearly with the oceanic mean depth established by the soundings for the original Atlantic cable, viz., 7,500 feet; but the result of the *Challenger* Expedition points to a much greater depth. This circumstance is by no means conclusive against the supposition that the satellite and the primary are covered with water in relatively equal quantities. The correctness of Sir John Herschel's demonstration, proving the tendency of the water on the lunar surface to flow to the hemisphere furthest from the earth, must be disproved before we reject

* $\frac{2028600 \times 5280}{130000000 \times 0.011364} = 7{,}250$ feet mean depth of terrestrial oceans, corresponding with water on the moon.

The Moon's Surface during the Lunar Night, as Seen by Light Reflected from the Earth.

the assumption that the quantity of water on the surface of the moon bears the same proportion to its mass as the quantity of water on the earth to the terrestrial mass. JOHN ERICSSON.

The illustration upon the opposite page is intended to represent the appearance of a section of the moon's surface, as seen by earth light—the light of the sun reflected from our planet during the lunar night. The appearance of the circular depressions, ordinarily supposed to indicate volcanic action, is equally suggestive of the operation described by Ericsson.

Professor Frankland tells us that the idea of former aqueous agency in the moon has received almost universal acceptance; but if water has at one time existed on the surface of the moon, whither has it disappeared? For lack of a better theory this authority hides the lunar oceans in interior caverns, left by the shrinkage of the moon in cooling; others would have us believe that the waters have withdrawn to the side of the selenic sphere never turned toward us; and still a third theory is that a vagrant and greedy comet has sucked up the lunar oceans and atmosphere, and carried them far beyond the reach of replevin into the trackless wastes of cosmic space. Compare Ericsson's well-reasoned conclusions with such wild guesses as these.

As the present study of solar physics dates from 1860, and Ericsson began his investigation four years later, he is one of the pioneers in this field, so fruitful in its promise of great revelations. Whatever the final conclusions, he is certain to be remembered as one who did much to stimulate and direct inquiry in this most important field of physical research. Ericsson's labors in this field continued until his death; they afforded him congenial occupation for his declining years, and removed him in a measure from the atmosphere of contention in which so large a part of his busy and aggressive career had been spent. They brought to him, too, the pleasure he esteemed chief of all—that of devoting twelve hours a day, for three hundred and sixty-five days in the year, to useful work without concern as to pecuniary reward.

CHAPTER XXXVIII.

THE HOME IN BEACH STREET.

The Philosophy of Generous Living.—Removal to St. John's Park.—Love of Flowers.—Description of the Home at 36 Beach Street—Changes in the Neighborhood.—The Park Destroyed.—Annoyances and Remedies.—Carlyle's Experience Repeated.—A Great Engineer as a Housekeeper.—Experience as a Rat-catcher.—Diary and Accounts.—Growing Eccentricities.—Prejudice against Modern Invention.—Human Inconsistency.—Hermit Life.—Spartan Habits.—Temperance Ideas.—Exact Methods of Living.—Celebrating Octogenarian Birthdays.—Recollections of Youthful Days.

SOME years after he had removed, in 1843, from the Astor House to No. 95 Franklin Street, and adopted the habit of taking his meals at the Union Club, Ericsson wrote to Mr. Sargent, at whose instance this change was made, to say, "You have added ten years to my life in calling my mind to generous living, by bringing me to the club. I can say with truth that I am now capable of undergoing twice as much labor as when I left the Astor House. The difference between living well and ill in this climate is in fact quite incredible. Men, like engines, require food to keep up steam." At Franklin Street he continued for twenty-one years, or until 1864, when his friends urged him to buy a house at No. 36 Beach Street, offered at the price of $20,000. Mr. Delamater, who had prospered through his connection with work upon the monitors, asked that the property be purchased for him, in case his friend did not desire to invest in it himself, generously adding, "If you do buy on your own account, the whole of the purchase money can be arranged for you with the aid of, yours truly, C. H. Delamater." The house was bought in April, 1864, and Mr. John A. Griswold, Ericsson's associate in the monitor contracts, who was then a member of Congress, wrote to say: "If I did not express my pleasure at hearing of your having se-

cured a dwelling-place at once comfortable and respectable, I certainly felt it. I know of no one more thoroughly entitled to such provision. My wonder is that you should so long have denied yourself. I think if you could not afford it yourself, I know of friends who would consider themselves able, as they certainly would be willing, to aid you, under the feeling that it was the least of your deserts."

Happily, Ericsson could afford it, and to the purchase money of the house he added several thousand dollars for repairing and furnishing, as appears from this statement of account:

Cost to put 36 Beach Street in good repair..........	$1,749.26
For furniture for 36 Beach Street..................	2,646.85
Cost to get into Beach Street..........	$4,396.11

The fact that this amount exceeded the estimated expenditure by more than twenty per cent., shows that in matters of household economy the skilled mathematician is as much at fault as the youngest housekeeper.

Beach Street is a short street running toward the Hudson River, on the west side of New York, a few blocks below Canal Street. At this time, it was the southern boundary of Saint John's Park, and the noble trees of this beautiful private square were in full view from Ericsson's front windows.

The grounds of the park were kept in excellent order, and the location was in every way desirable for one who was not seeking a fashionable quarter. The busy engineer was accustomed to stand, in the early spring, at his open windows and watch with delight the bursting buds of the beeches and chestnuts, some of the finest on Manhattan Island. He loved the green grass and sight of flowers, trying with indifferent success to establish flower-beds in his little back-yard, so that he might occasionally see his favorite, the rose.

His house was one of a row of comfortable residences standing on full city lots, and having an air of dignity and old-time elegance recalling the days when the City Hall Park was a centre of fashion. The marble steps, the carved door-casings and fan-lights, the massive mahogany fittings of the

interior, all bespoke the state of earlier occupants. The forces of steam and iron, which its new owner had spent his life in developing, were fast transforming that quarter of the town, but this little oasis of a park still remained as a memorial of better days. Commerce now pressed in from all sides, and soon the park grounds were in demand for a freight depot; railroad cars and tracks displaced the stately trees; bare walls suc-

Exterior View of Ericsson's House, No. 36 Beach Street, New York, 1890.

ceeded to pleasant verdure; the rattle of carts and the screech of locomotives followed the singing of birds and the chatter of squirrels. To oblige a friend, Ericsson joined in the transfer of the park rights to the Hudson River Railroad Company; but if he lost this bit of sentiment out of his life, he gratified a deeper feeling by succoring starving Swedes with the money he thus received. The neighborhood henceforth deteriorated

rapidly in character, and a tenement population displaced the more quiet residents. The owner of number 36 talked of moving, but he found it difficult to suit himself elsewhere, and with years came a growing horror of change. Besides, he began to realize that he had found a good hiding-place, and, as he grimly said, the ladies ceased to visit him in that unpromising locality. If they absented themselves, other enemies to repose were constantly with him. The reflection from the walls of the freight-house disturbed him as he sat at his desk, just under the front windows, and he had an invincible prejudice against curtains or blinds. A medley of inharmonious sounds interfered with his rest at night, and his work during the day. The rattle of drays, carrying their heavy loads of railroad freight, made a constant racket, and the jarring motion of a stationary engine across the street disturbed his sleep, until he adopted the expedient of inserting numerous thicknesses of felting under his bed-posts. As he shared Thomas Carlyle's antipathy to a crowing cock, he was obliged to follow Mrs. Carlyle's plan of purchasing all the chickens in his neighborhood to secure the privilege of wringing their necks. With the owners of barking dogs, agreements of this sort were entered into:

New York, August 16, 1877.

I herewith agree to remove the dog now on the premises 37 North Moore Street, and further, not to keep any dog on said premises for the term of one year from date, for the consideration of five dollars paid to me by Captain John Ericsson.

Charles Herbert.

He obtained permission from a neighbor to enter his premises and pad the wall of his room with mattresses—covered to correspond with the furniture—so as to shut out the sound of a piano separated by only a thin party-wall from the desk at which he worked.

By an offer of two handsome gold watches, he endeavored to persuade two young ladies who practised their scales in another house adjoining to postpone their exercises until his morning sleep was over. With such ingenious and conciliatory methods he tried to secure the quiet so essential to his work.

But there were some intruders upon his peace who were proof against his beguilements. When he took possession of his new quarters he found his occupancy disputed by a numerous horde of rats, who considered themselves tenants at will, and stubbornly refused to yield possession. "Regarding the situation as a problem to be solved by mechanical means, with his own hands he drew the plans for a vast and mighty trap. To the leading idea (of a water-tank beneath a trap-door) he laid no claim, but the details were wholly new, and upon an unheard-of scale. Tracings were made by an assistant draughtsman, and went the rounds of the shop; the pattern-maker, the brass-founder, the finisher, the carpenter, the tinsmith, each had a share in this novel work. At last it was completed and erected; it filled up half the basement, and was baited with half a cheese. He had originally intended to use a whole one, but though cost had been disregarded in making the trap, he suddenly became gravely economical in the matter of bait, and at last decided that one moiety would suffice; the other being placed in an adjoining room, to guide the noble army of martyrs in the road to ruin. But he had underestimated the cunning of the rodents; as a place for keeping cheese in safety, the ponderous engine answered admirably, but it did not even frighten away the obnoxious animals; and he was forced to admit that 'these little beasts have brains altogether too big for their heads.'

"Before this time, when some over-ambitious and unsuccessful piece of mechanism came to his notice, he used to say, like many another, 'the man who contrived that couldn't plan a rat trap.' And the force of habit sometimes impelled him even afterward to use the same familiar ejaculation; but the memory of this failure was ever present with him, and with a merry twinkle in his clear blue eyes he invariably added, 'and I couldn't do that, either.'" *

Ericsson was assisted in his engineering work, during the closing years of his life, by Mr. V. F. Lassöe, a native of Denmark, and his private secretary for twenty-five years was Mr. Samuel W. Taylor, a gentleman whose thorough acquaintance with his peculiar ways made him indispensable. He grew so

* Professor C. W. MacCord in the Scientific American.

accustomed to his secretary's clear chirography that when, in his later years, the type-writer favored him with a letter, he would insist upon having it copied into script before he would read it. Indeed, the hostility to invention in matters concerning himself, shown by this doughty champion of progress against prejudice, is a curious commentary upon the inconsistency of human nature. He was accustomed to ascribe naval hostility to innovation, to the confinement of naval officers within the narrow limits of a man-of-war, forgetting that he was himself confined within a still more contracted sphere, and that he was quite as much the victim of conservative prejudices. Numerous objections were urged against the copying-press when it was first introduced, and those existing in Ericsson's mind were never overcome. He would have nothing but manuscript copies of his letters, sometimes sending the copy with his signature, and retaining the original.

As he was particular to keep copies of his letters, this involved no small amount of unnecessary labor. In the matter of keeping accounts he was even more peculiar, and it was difficult to follow his financial transactions, as the memoranda on his checks-books were his only record of money received or coming due to him. Yet his receipts in one day counted a single item of half a million dollars paid in ten $50,000 Treasury certificates. The papers transferred to me for the preparation of this biography numbered nearly twelve thousand, and included very complete files of letters received and sent after 1860. Most of the papers of an earlier date were destroyed in 1886. The destruction of his diaries, containing daily memoranda in a curious mixture of Swedish and English, was decreed about the same time. The entries, extending over fifty years, were contained in a series of little blank-books bound in red leather, such as are used for keeping accounts. I discovered these diaries standing in imposing array one day upon Ericsson's shelves; when I next saw them nothing but the covers remained. Their leaves, containing the story of Ericsson's life for half a century, had been put under a cutting machine, sliced into fragments, and sent to the paper mill.

The indiscretion of Carlyle's biographer, in exposing some of his unhappy experiences, prompted this act of destruction.

Ericsson had no time to revise his diary, and was not disposed to intrust the task to another. In looking it over he found in it—as any man would under like circumstances—evidences of mistaken ideas and impressions that he did not care to perpetuate. The only way a growing man can live at peace with such a chronicle is never to look at it. To come into daily intercourse with one's dead past is like consorting with the dwellers in the catacombs. Occasionally, when his attention was called to some opinion he had expressed years before, or to some drawing he had forgotten, Ericsson found what he regarded as an indictment against himself so unanswerable, that he was led to exclaim in his vigorous way:

"Did I write that? Is that my drawing? Then I must have been a d——d fool when I made it!"

Though he adhered with extraordinary tenacity to opinions once deliberately formed, and the more tenaciously the more he was opposed, the natural movement of progress would carry him so far beyond his conclusions of a given time that he came finally to look back upon them with that sort of half-pitying contempt the wise man bestows upon the errors once fellowshipped, but no longer identified with his mental processes.

John Ericsson lived for his work, and he had no wish that anything beyond a record of that should survive him. In 1888 the curator of the Stockholm Museum asked for some of his personal belongings, to be added to its treasures. In his impatience to deny this inadmissible request, the subject of it spent thirty dollars in speeding under the Atlantic this telegraphic reply:

ARTHUR HAZELIUS, STOCKHOLM: Documents received. Accept my cordial thanks, but permit me to inform you that I take no interest in museums which preserve relics of barbarism and ignorance of past generations. Again, time will soon convert such relics into heaps of mould.

Please do not prepare any place for the reception of relics expected from me, as nothing will be left after me to show how imperfect my knowledge was. I have already destroyed upward of one thousand drawings, and numerous models, to prevent posterity from supposing that my knowledge was as imperfect as said relics would indicate. Nothing will be left at last but the corpse of

JOHN ERICSSON.

NEW YORK, June 19, 1888.

Within another year Ericsson was dead, and the museum was soon in proud possession of the entire furniture and fittings of the room where he labored for a quarter of a century. They were transported to Stockholm, and placed in a room reproducing, as nearly as possible, his work-room in Beach Street. A copy of the photograph showing the appearance of the room at the time of Ericsson's death is given on page 314.

The fact that Ericsson never rode upon the elevated railroad is an illustration of his conservatism in minor matters. He declared that the Czar of Russia would be assassinated if he should build such a structure through the streets of St. Petersburg. He never saw the Central Park, and would never have seen the Brooklyn Bridge, had not his secretary driven on it when they were out together, without telling him where they were going. He was one of the first investors in the Atlantic telegraph, but he always wondered at himself for this venture, as he was ready at that time to furnish a conclusive demonstration of the impossibility of making the cable a success. He was accustomed to refer to this as an illustration of the fallibility of engineering judgments. It was long before he could believe in the reality of the telephone, and he offered to bet his secretary a suit of clothes that he was deceived when he supposed that he heard through it the voice of a distant person. In the end he conceived a great admiration for its inventor, Edison.

Ericsson dwelt, with an old man's pride, upon the fact that he was in good working condition for three hundred and sixty-five days in the year, in spite of his confinement, summer and winter, to a district of the city where the gutters ran with filth, the air was heavy with the mingled odors of a tenement district, and not a pleasant sight or sound regaled his senses. To a friend, who had withdrawn to his country-place for the summer, he wrote in July, 1862, "I also enjoy a change of air as usual during July and August, during which months the fumes from the gutters are much stronger than at other seasons, productive of a decided change of the atmospheric constituents, beneficial, it would appear, to the 'worn-out' old fellow who has had no occasion to seek any other than the change mentioned during a succession of forty-three years. Indeed, so well does

it agree with him that he now can boast of pristine vigor, and may be found at 11 P.M., during our pleasant warm evenings, stooping over his drawing-table." There was something, no doubt, of octogenarian delusion in this, and his physician's report would have modified the statement. He never would own, even to himself, that he was out of condition, and kept at work during the last twelve or fourteen years of his life in spite of the fact that he suffered from the disorder that resulted in the death of his son. He insisted upon studying his own case, and would follow the doctor's directions only so far as he approved them. His physician was under a pledge to inform him of the first symptom of approaching dissolution, and he resolved that he would not take to his bed except in the last extremity.

Until within a few days of his death, he followed the rigid régime described in previous chapters. The food and drink constituting his simple diet were chosen with care and measured with exactness. The windows of his sleeping-room must be opened just so many inches, summer and winter; he must have his calisthenics for two hours each morning, followed by a sponge-bath and vigorous rubbing; as plumbing was one of his antipathies, there was no bath-room in his house. "I have important work before me," he wrote after he had passed his eighty-second year, "and hence live like a man training for a fight. My reward is unbroken health. I digest my food as well now as I did at thirty. Nor is my muscle less tough and elastic than at that age." This view of his bodily conditions was, as I have said, somewhat too optimistic, although true to the general fact.

When he was over sixty years old, a visitor at Mr. Stoughton's house, coming unannounced into the room where the family were gathered, was astounded by the spectacle of the famed designer of the *Monitor* giving proof of his athletic abilities by standing upon his head.

Captain Ericsson abandoned the use of intoxicants when he was fifty years old, as he once told me. His usual beverages were water, cooled in summer with ice to a temperature 15° to 20° below that of the air, and hot tea made very strong. While he lived in England, he followed the custom of the country:

this he describes as at that time a continuous round of eating and drinking. He seems, later on, to have acquired a prejudice against drinking habits. To an impecunious countryman who asked for money to fit up a liquor saloon, he answered that he would never give a dollar to help anyone to engage in the demoralizing business of liquor selling. Again, on receipt of a bill from the contractors for one of his monitors for the expenses of a trial trip, his secretary wrote, saying:

> Captain Ericsson directs me to ask you to inform him if, of your own knowledge, 156 bottles of spirituous liquors were consumed by the guests invited to be present during said trial trip. If the above quantity of liquor was really consumed, the occasion looks more like a bacchanalian feast than a trial trip of a small gun-boat. Captain Ericsson desires to be informed if the trial of the vessel was really made the occasion of such a disgraceful feast before settling the bill.

Still he did not believe in sumptuary laws. Replying to a pamphlet suggesting their adoption in Sweden, he said: "The great danger that threatens our dear country cannot be averted by a royal prohibition of the distillation of spirits. Evidently, you have not considered how many crimes would result from such a prohibition, prompted by a love of gain and a desire for the forbidden liquor. Nor would the liberal-minded Swede long submit to such restraint. Consideration should also be given to the fact that the majority are accustomed to take brandy, and that most of them consider this liquor to be wholesome." In place of prohibition he recommended the plan, subsequently adopted and applied by Act of Congress to the National Military and Naval Academies, of instructing the young as to the injurious effects of strong liquors. After he had pursued his temperance régime for many years, one of his oldest friends took occasion to remind him of earlier experiences, saying: "It does not seem to me forty years or more since you could put your full share of three bottles of champagne under your jacket of a hot day at the Union Club. No, nor that time since you could take your dozen oysters of an evening at Florence's, and wash them down with a stiff glass of whiskey toddy. And now you pass as a water-drinker, and think me no

better than one of the wicked because I have drunk a pint of wine every day for these forty years." But sharing three bottles of wine was a very rare indulgence at any time, and even this boon companion of his convivial years could recall no similar experience.

The domestic establishment at 36 Beach Street had been for many years under the care of a tidy little Irish woman, who was cook as well as housekeeper. She had learned to accommodate herself to her master's simple tastes and eccentric ways; knew just how long to keep the two loaves of bread adorning his dining-room mantel until they had grown sufficiently stale for his use; knew how to place the two hundred and forty pins required to make faultlessly smooth the sheet covering the mattress upon which he slept; stood guard over his privacy, and kept her housewifely zeal for cleanliness subject to the necessities of his comfort. Indeed, Ann Cassidy thoroughly avenged her sex upon the man who sought to make himself independent of women, for she succeeded in making at least one of them indispensable to him.

The Beach Street house was put into perfect order when Ericsson took possession of it, an observatory upon the roof for solar experiments being added; but he was unwilling to be disturbed by the confusion of repairs, and it gradually assimilated itself to the general shabbiness of the neighborhood. Symptoms of house-cleaning gave him such distress, that attempts in that direction were abandoned unless he had consented to them previously; and there were positive orders that nothing should be done without his directions. He was so opposed to newness, that the carpets in the rooms he occupied were replaced piece by piece as they wore out, until half a dozen patterns were to be found upon a single floor, and a new carpet was hung up for a year in the attic to season before it was considered fit for use. The smell of new paint so troubled him, that when it had been on one occasion applied to a new tin roof upon his piazza, a workman was required to soak it off with gallons of still more offensive benzine.

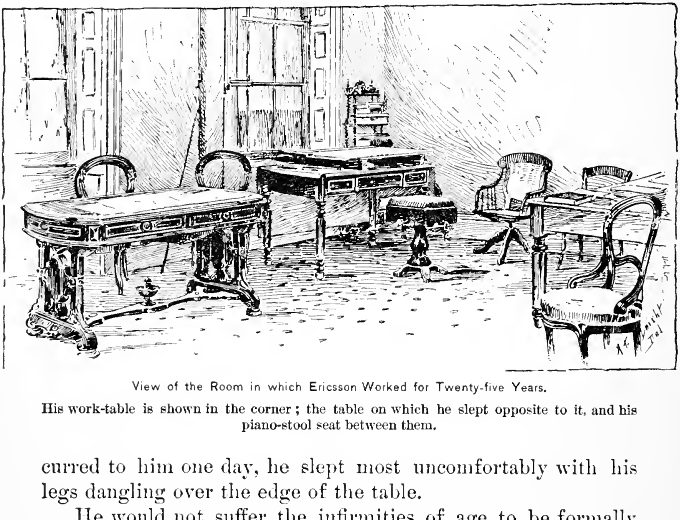
This was the condition of Ericsson's house toward the end of his life: His parlor and dining-room, with their heavy chandeliers and mantel mirrors, had a certain air of old-fash-

ioned dignity, but the handsomely finished and exquisitely polished specimens of his solar apparatus occupied every corner of the parlor and gave it the appearance of an alcove in the Patent Office. An oil portrait belonging to a friend, a bust of Mr. E. W. Stoughton, an elaborately engraved and framed copy of the resolutions passed by the Legislature of the State of New York on the occasion of the *Monitor* fight, and a portrait of Gustavus V. Fox, were the only specimens of artistic adornment displayed about the house. Ericsson never found time for the cultivation of a taste for art, and there was a noteworthy absence in his house of everything appealing to æsthetic sentiment; but the pins in the cushion on his bedroom bureau were always arranged by himself so that they should be in exact mathematical rows. Utility, and not taste, controlled the appointments of his house. Emancipated from the tyranny of domestic tradition, he was permitted to make it what he intended it should be—the abiding place of the genius of labor, the apostle of the steam engine, the prime minister of the tremendous forces shaping modern civilization. What time had he, bound to the service of these stupendous powers, to do aught but their bidding? Domestic life, luxury, and ease were not for him. His keen eye must see only the path of stern, absorbing labor; his powerful brain and indomitable will must be ever in command of his unwearied hands, in their never-ending toil. No wife, no children must intrude the tenderness of love to soften the rigor of his purpose, or to interfere for one moment with his chosen work.

The room used by Ericsson when at work was large and pleasant, occupying the entire front of twenty-five feet, the partition of the hall bedroom having been cut away to form an alcove. Here stood the table covered by the inclined drawing-board upon which the master's hand had wrought such marvels.

"As a draughtsman," Professor MacCord testifies, "Ericsson had no rival, past or present, and the outlines of new devices grew upon the paper as if by magic." This is the testimony of all of his assistants. He was never so happy as when engaged with his drawing. At his side stood always ready, a store of pencils carefully sharpened to a convenient length for

his holder. Near at hand was another box filled with ends of rubber and an assortment of spectacles; while a third tiny box held bits of plaster cut to exact length to cover the splits in his finger-nails that gave token of advancing years. He sat at his work upon an ordinary horse-hair piano-stool raised to a convenient height by the addition of a rough wooden box, unpainted, and polished only by use. This box, or a dictionary, served him for a pillow when he turned aside from his work to stretch himself out at full length for a nap on a table standing opposite his desk. Until the bright idea of lengthening it oc-



View of the Room in which Ericsson Worked for Twenty-five Years.

His work-table is shown in the corner; the table on which he slept opposite to it, and his piano-stool seat between them.

curred to him one day, he slept most uncomfortably with his legs dangling over the edge of the table.

He would not suffer the infirmities of age to be formally presented; they must come upon him unannounced, and no hint of their presence was allowed. The walnut table where he lay, when during his working hours he suffered sleep to steal upon him, was only a degree less hard than the bed to which he retired after midnight for his seven hours of dreamless repose. No lounge, no arm-chair, no contrivance of any kind for the relaxation natural to old age, was found in the

home of this Spartan octogenarian. No persuasion could induce him to adopt the luxury of a bed in the daytime, and he refused to use a reclining chair brought to him in his dying hours, because it was made upon a false mechanical principle. Toward the end he stretched himself at more frequent intervals and for longer periods upon his table, but it required much gentle force to remove him to his bed for his "last, long, dreamless sleep."

Before the large mantel in Ericsson's work-room stood two vases made from the wood of the vessels sunk by the *Merrimac*, the *Cumberland* and the *Congress*. Near by were two crockery pitchers containing pyramids of artificial flowers. "We will have flowers," said this lover of roses. "But natural flowers fade and require attention—let us have these."

"On a projecting pilaster near the left of his drawing-table [which is seen in the cut on the opposite page] were two bell-pulls, marked respectively 'L' and 'T.' These were later additions, leading to the room above, occupied by his superintending engineer and his secretary. In the early days he employed no such labor-saving device, but, marching to the hall-door, he would summon 'Mr. Lassöe' or 'Mr. Taylor,' with a deep chest-voice, not musical, but clear as a trumpet, and of a volume which would have wakened them had they been sleeping, and at least have startled them if they had been dead.

"One mechanical appliance, however, there was even then in this room. His fireplace, which in winter was generously fed with Cumberland coal, had, as he conceived, some affection of the throat, which he proceeded to treat in a manner of his own. He had made for it a cast-iron damper, turning on pivots at the ends, and operated from the front by means of a rod fitted with a screw and a polished hand-wheel, the tracings for which were duly returned from Delamater's marked, with the shop name, 'Reversing gear for Captain Ericsson's fireplace,' a bit of humor which he keenly enjoyed; if there was no music in his voice, there was no lack of it in his laughter, which was free, hearty, and contagious.

"Upon the oval table was a model of a gun-carriage, with a gun for firing torpedoes, which, having been brought down some years ago for exhibition to some gentlemen interested in

the subject, happened to be left there, and it is the only model which ever was in this room for any length of time." *

Ericsson's bedroom, in the rear of his house, was bright and sunny, but the outlook from the windows was over a dreary waste of shabby and odorous stables and tenement-houses, and the square plot in the centre of the yard, where flowers and grass were intended to grow, was covered by a wooden platform for setting up experimental solar engines. He was by no means regardless of comfort, but his ideas of what was most essential to comfort differed from the conventional standard. Sunlight was good for him, and hence blinds and curtains were forbidden. Fresh paints were poison, and the dyes in new carpets subject to the same objection; so he would have none of them where he dwelt. Sanitary, and not sentimental, considerations controlled his household. Around himself he drew a sacred circle within which none must obtrude. Beyond this all was free, and the housekeeper maintained her tidy ménage, and set up her altar to the Virgin in an upper room, without molestation.

Curious contrivances here and there about his rooms illustrated the great engineer's ingenuity in providing for his personal convenience. In a doorway of his bedroom two short ropes with nippers at the ends hung at about the height of his shoulders. To these nippers he fastened his coat, so that he could get into it without lifting too high his rheumatic arms, or subjecting himself to the humiliation of asking assistance. Eighteen hods of coal were placed just outside his bedroom door, and two stokers' iron pokers, six feet in length, enabled him to stir up his fire without approaching it too nearly, or calling upòn a servant for help. Open fireplaces were all he used, and no furnace was permitted to poison the air of his house. A tin saucepan, with a handle several feet in length and crooked so as to hang on to the edge of the fender, allowed him to heat the water for shaving without burning his face. Everything about him gave proof of his independent spirit and his unwillingness to invoke the aid of others in personal matters. He was accustomed to tie up the articles of his wardrobe not in immediate use, in brown paper packages, and store them away

* Professor C. W. MacCord in the Scientific American.

in a closet of his bedroom. Once a year, he would stand upon a chair and hand these packages solemnly down to his secretary, who in his turn solemnly rid them of the twelve months accumulation of dust, and handed them up again for further repose upon the shelves. This appears to have been the extent of Ericsson's concession to housekeeping proprieties. Summer and winter, he wore vests and stocks of buff Marseilles or piqué; this material having once attracted his fancy, he had bought one hundred and fifty yards of it and used it for these garments during the remainder of his life. When the supply was exhausted and it was found impossible to match the material, the well-worn vests were patched and repatched with remnants saved when the cloth was cut. Separated so much from contact with his fellows, he grew more and more eccentric, and while he was quite conscious of this, his joy was in his work and he did not care to change. Those who had business with him and who understood his ways, could always gain access to him, but for visits of mere curiosity he had no tolerance. On the recurring anniversaries of his birth, toward the end of his life, congratulations were sent to him by telegram and letter from friends and admirers, a few of the more venturesome calling to tender their compliments in person. How such visitors were received is indicated by this copy of a memorandum given to his secretary for his guidance on such an occasion.

July 31, 1884.—Mem., Capt. E.'s Instructions.

Tell the gentlemen who may do me the honor to call, that I positively refuse to appear, as I am tired of being described.

Regarding my profession, I desire to be useful, and love to work; but I desire that my works should speak for themselves.

As to congratulations, my friends know that I prefer a few friendly lines over an autograph.

I have not time to examine my correspondence to-day, as I should like to send a certain scientific document by Saturday's mail.*

* Ericsson was a constant contributor to the newspapers—scientific and others; writing not for pay, but because he was interested in the subject he discussed. He would frequently furnish not only the article but the illustrations to accompany it. On one occasion he sent an article to a New York daily paper. As it did not appear promptly he sent a copy to a rival sheet. The result was that two papers that had a genius for differing were for once found in

Not one of the expected congratulations would I publish.

You can show the solar apparatus if you see fit. The result of my investigation is a positive demonstration that the temperature of the solar surface exceeds three million degrees of F.

The national melodies, sung by the Swedish societies who gathered in front of his house on his last birthday, touched Ericsson profoundly. He did not appear to acknowledge the courtesy, it is true, but, in the privacy of his own room, he listened intently, and his eyes filled with the tears of tender recollection

> "That is not akin to pain,
> And resembles sorrow only,
> As the mist resembles the rain."

If the avenues to his heart were known to but few, they were far from being untrodden ways. A Swedish traveller who called, at the time of dedication of the monument erected at Långbanshyttan, to give an account of the celebration there, says of his interview: "After having waited a few minutes, I heard somebody coming very quickly down the stairs, and a moment afterward I saluted one of the most renowned persons of the century. I gave him the views of Långbanshyttan after having delivered my message. This was one of the most interesting moments of my journey. To see how the warm-hearted patriot was overcome with emotion, how he for a long time stood as if rooted to the floor, and gazed upon the pictures recalling the scenes of his childhood, and the humble dwelling where he passed his youth, cannot be described in words. At last he said, 'Yes, I know my home very well,' and at the same time a few tears, which surely came from the depths of his heart, appeared in his eyes, as he continued to gaze upon the unpretending pictures which showed him how his friends in the old places had done him honor."

> "The heart has its own memory like the mind."

the most striking accord. Each printed on the same day Ericsson's article as an editorial, and the exact similarity in expression and opinion was the subject of no small amusement to critical contemporaries.

Tegnier, the poet of Vermland, recalling the scenes of his youth, said in his old age: "The verdure of spring, the cool shade of the wood, the refreshing waves, the odor of the pine, the perfume of the flowers, and the sweet breath of the morning air, all are still fresh in remembrance. The distractions of town-life, of study among books unlimited, the dust of the highways of learning, have never obscured these recollections, and they refresh me as do the wells that spring out of the desert the thirsty traveller."

Among the same associations John Ericsson obtained his deepest impressions, and as the sands of the desert cover hidden waters, so beneath his life of absorbing devotion to utilitarian pursuits lay hidden the well-springs of sentiment, having their origin in recollection of the days when Olaf and Sophia Ericsson gathered their little family around them in the Vermland forest, when all was lost save love.

CHAPTER XXXIX.

THE CLOSE OF A USEFUL LIFE.

Resolution to Die in the Harness.—The Last Invention.—Death of Cornelius H. Delamater.—Its Effect upon Ericsson.—His End Approaches.—Remarkable Tenacity of Life.—His Death upon the Anniversary of the *Monitor* and *Merrimac* Contest.—Funeral Ceremonies.—Sweden Asks for the Remains.—Imposing Ceremonies Attending Their Transfer.—Two Nations Join in Honoring the Dead.—His Estate, and Directions as to its Disposition.—The Dream of Piranesi.—Finis.

IN 1856 Ericsson promised his Swedish relatives and friends that he would return to them when he was eighty years old, and dwell at his ease in his native land. But the usual changes came with time. Those nearest and dearest to him were no longer with the living, and the familiar places had lost the charm of familiar presence. His zeal for invention continued unabated, and when the twenty-seven years had passed and he was reminded of his promise, the attraction of work was stronger than his desire to visit Sweden. "I propose to continue at work," he now said, "so long as I can stand at the drawing-board."

Five years more passed and he was still busied with his project for controlling solar heat—the culmination of the studies begun nearly three score years and ten before, in Jemtland with his flame engine. In the yard attached to his house he had set up a large solar engine. Needing power to test it, in December, 1888, he began work upon the design for a "small motor engine." To this he devoted the last week of the year, and, as usual, he made with his own hands all the working drawings. These went to the shop and the engine was returned completed by February 1, 1889. This little engine was John Ericsson's last finished work. His secretary saw that his powers were waning, and urged him to refrain from further

exertion, but he pointed to his new engine as proof that there was no occasion for anxiety. On February 7th he received a great shock from the announcement of the death of Cornelius H. Delamater, in the sixty-eighth year of his age. This event sundered relations of business and friendship extending over half a century; it deprived him of the chief coadjutor in his work, and it gave unpleasant interpretation to his own bodily symptoms. Though these daily grew more alarming to his friends, he would not permit a physician to be called; when the swelling of his limbs suggested dropsy, he directed his secretary to consult medical treatises, and report without asking medical advice. It soon became apparent that there was no evidence of dropsy, and the heart was next held accountable for symptoms only to be explained on the theory of approaching dissolution. "A diagram of the pulse resembled a saw with every sixth and tenth tooth broken off," as the sick man described it. In spite of increasing weakness he still declined assistance, and cautioned his attendants not to speak of his illness. "At my age," he said, "such a report would interfere with future plans, and most likely with future usefulness." He was able to continue at work and was in excellent spirits. On February 23d a change in appearance was noted, and he complained of increased exhaustion, and of rest disturbed by the constant occupation of his mind at night with planning and working out new mechanical devices.

The crisis approached, and from this time the faithful secretary forsook his home in the suburbs of New York and remained constantly upon the watch. The dying man continued his daily routine, and the early morning hours were still devoted to severe physical exercise, now so much beyond his strength. He showed unusual irritability, though his habitual courtesy to those about him remained unchanged. Soon he was forced to ask for assistance in dressing and to forego his laborious gymnastics; fever and thirst increased, appetite failed, and he finally consented to have a physician consulted. The doctor, when he received the report of his condition, insisted upon calling. Though Ericsson still kept about the house, and still took his frequent naps upon the top of his table, with his box for a pillow, he was already "two-thirds dead," as the doctor re-

ported. It was only his indomitable will that survived. To his failing sight fog seemed to fill the room, and milk at a temperature of 175 degrees could not convey the sensation of warmth to his dulled senses. Yet, in spite of this, there were wonderful flashes of the old vigor. His instructions concerning his affairs were precise and emphatic; he still retained interest enough in the world around him to send for an extra, which a newsboy cried under his window on March 4th, and to read President Harrison's inaugural address. Tired of his enforced idleness, he suggested that the evenings "now passed in looking at each other be occupied with intellectual conversation."

On March 5th came the anniversary of the day on which the *Monitor* received her first sailing orders. Ericsson was still able to descend the stairs to his meals, and enjoyed his food. He was quite vivacious and his voice had the old ring in it, but he dozed through much of the day, and far into the night, stretched upon the table where a coverlid had been spread, and a hard pillow substituted for the wooden box. His secretary was greatly distressed by his painful moaning, but it was not until three o'clock in the morning of March 6th that he was able to persuade him, by gentle violence, to withdraw to his bed. Ericsson was resolved to fall with harness on. His old friend and physician, Dr. Thomas M. Markoe, had been sent for. At 11.15 A.M. he appeared. As he approached the bedside of his patient, Mr. Taylor said, "Captain, here is Dr. Markoe to see you." "Who?" he asked, in a loud tone; "who sent for him?"

Taking the hand of the dying man, Dr. Markoe asked: "How do you feel, Captain?" A smile of recognition lighted the wan face, and after a pause Ericsson said, in distinct tones: "Markoe, can a man who has Bright's disease do any more work?"

To this the doctor answered: "Captain, a man who has Bright's disease has no right to do any work." Mr. Taylor, to whose memoranda I am indebted for these facts, says: "I knew that the death-knell had sounded, for he had told me hundreds of times that when he knew that his usefulness to mankind was at an end, he would not make an effort to live another minute." Mr. Taylor says further:

"Dr. Markoe sent a professional nurse at once to relieve me, and after this I saw Captain Ericsson only at intervals. My presence suggested to his mind matters of business, and he would give me peremptory orders, ending with the command to dress him at once.

"At nine P.M., Wednesday, March 6th, I took the housekeeper to his bedside, to bid him good-night, as she had never failed to do for thirty years, and more. I imagine that blindness was coming on, as he could not see her uplifted hand. He gently squeezed her fingers and said, 'God bless you, my child!'

"Thursday, March 7th, Dr. Boullee reports that when he felt it to be his duty to inform the Captain of his very precarious condition, he merely remarked, 'Then give me rest.'

"At 11.30 P.M. I arranged his pillows and spoke to him. He gazed into my face, and with a smile said:

"'I am resting. This rest is magnificent; more beautiful than words can tell!'

"I am positive that he was absolutely without pain, and perfectly conscious when I left, a minute later. At 12.30 A.M. I was called to see him breathe his last, and at 12.39 A.M., with just three gentle movements of the lips, the noble friend, the great and good man, ended his life."

Thus, in the first hour of the morning of March 8, 1889—the anniversary of the event giving chief significance to his name—John Ericsson passed away. He had so separated himself from his fellows, and so far outlived the era of his best known works, that few realized the historical significance of his death until they read the record of his achievements in the biographical notices filling the papers. The Ericsson of the Rainhill contest, of the *Princeton*, of the caloric engine and the caloric ship, was forgotten; the Ericsson of the *Monitor* was but vaguely associated with a living presence, and the solar engine brought to most men's minds only the dim suggestion of an inventor's dream. Stories of the hermit life in Beach Street had occasionally floated upon the air, as the fancies of reporters turned that way, but they had made no permanent lodgement in men's minds.

On the day of his funeral, March 11, 1889, the pall-bearers,

thirty-two in number; his personal friends, and the representatives of various societies, Swedish and others, gathered at the desolate house in Beach Street. From there they proceeded in carriages, and without ceremony, to Trinity Church, in lower Broadway, where the rector, Rev. Morgan Dix, D.D., and his assistants read the Burial Service, and the fine choir sang Cardinal Newman's noble hymn—"Lead, kindly light." On the coffin, with other tributes, lay two beautiful palm leaves tied with a broad black ribbon and bearing this inscription, *Hunters' Regiment No. 23, Royal Swedish Army.* No offering could have been more grateful, for with the service thus signified Ericsson's dearest recollections were associated. However other titles might accumulate upon him, he would insist upon but one, and that was "Captain" Ericsson, late of the 23d Fält Zägar.

In Second Street, on the east side of New York City, is located the "Marble Cemetery," dating back to the time of James Monroe, fifth President of the United States, who was buried there in 1831. Then in the suburbs, it was at the time of Ericsson's death surrounded by a population similar to that in the vicinity of his Beach Street house. To this cemetery his body was carried and placed in a receiving vault to await a decision as to its final resting-place. A procession accompanied it, consisting only of the few carriages containing those connected with the dead by personal association, and there was nothing in the nature of a public funeral. As the body was deposited in the vault, a funeral hymn was sung by a Swedish glee club, and the Odd Fellows of Ericsson's Lodge, the Amaranthus, performed their simple rites, which seemed more in consonance with the character of the departed than did the more elaborate ritual of the Church. Following Ericsson's death, came various suggestions as to the proper place for his final interment, and among these was the proposition to place his remains in the Livingston Vault of Trinity Church-yard, beside those of Robert Fulton. The Legislature of the State of New York, on May 8, 1889, passed an act authorizing the City of New York to expend $10,000 in erecting a monument to Ericsson in one of the public parks. Two bills, one appropriating $50,000 and the other $30,000, for another monument, were

introduced into the House of Representatives of the American Congress, and committed to the slow processes of Federal legislation. A month after Ericsson's burial, this communication was sent to the Department of State from the Legation of the United States at Stockholm:

LEGATION OF THE UNITED STATES,
STOCKHOLM, April 10, 1889.

HON. JAMES G. BLAINE, SECRETARY OF STATE,
Washington, D. C.

SIR: On yesterday I had the honor to transmit to you a cablegram in the following words: "Blaine, Washington: Sweden would regard with extreme favor Ericsson's body sent home by man-of-war.
"MAGEE."

This cablegram was the result of a conversation with the Under Secretary of State for the Royal United Kingdoms of Sweden and Norway, who asked me to forward it on request of Count Ehrensvard, Minister of Foreign Affairs. Unquestionably the Government, as well as the people, of Sweden would regard such an action on the part of the Government of the United States as highly complimentary and satisfactory. I have made no expression upon the subject, and report simply my reason for forwarding the cablegram. If such action is taken I would suggest it be in June, as navigation will hardly be opened here before the latter part of May. Perhaps a formal reply should be made to the Department here as to the determination in the matter of the Government of the United States. Awaiting the same, I have the honor, etc.

RUFUS MAGEE.

No action was taken upon this suggestion for eight months; then this letter was sent to the Navy Department by the Department of State:

DEPARTMENT OF STATE,
WASHINGTON, December 14, 1889.

THE HONORABLE, THE SECRETARY OF THE NAVY.

SIR: It having been intimated to this Government that the Government of Sweden would regard it as a graceful act if the remains of the late Captain John Ericsson should be conveyed to his native country on board of a United States vessel of war, I have the honor to suggest the matter for your consideration and action, if deemed practicable. I have the honor to be, sir, your obedient servant,

JAMES G. BLAINE.

Finally, in June, 1890, the Secretary of the Navy wrote to the executors of the Ericsson estate, informing them that the

U. S. S. *Essex* was at their service for carrying out the expressed wish of the Swedish Government. The *Essex* was one of the old and inferior vessels of the Navy, and it was soon made apparent that her employment on such duty would not satisfy public sentiment. Accordingly, the Navy Department reversed its decision and substituted for the *Essex* one of the vessels of the "new navy."

The *Baltimore*, a fine cruiser under the command of Captain W. S. Schley, U.S.N., whose rescue of the Greely party of Arctic explorers had made his name favorably known throughout the country, was the vessel finally chosen. And this order was issued from the Navy Department:

NAVY DEPARTMENT,
WASHINGTON, August 2, 1890.

REAR-ADMIRAL D. L. BRAINE,
U. S. NAVY, COMMANDANT, NAVY YARD, NEW YORK.

SIR: The Department has fixed the afternoon of Saturday, August 23d, as the time for the embarkation of the remains of the late Captain John Ericsson for transportation to his native country, on board the United States ship *Baltimore*, and it entrusts to you the direction of all the arrangements connected with the ceremony.

The Department has assumed this duty in response to an intimation conveyed by the Minister of Foreign Affairs of Sweden and Norway, through the United States Minister at Stockholm, to the Department of State, that it would be regarded by the Government and people of Sweden with peculiar satisfaction.

Apart from the desire thus expressed, it is in the highest degree appropriate that the United States, through its Navy, should pay this final tribute to the memory of the great Swedish inventor. As the most famous representative of the Scandinavian race in America, his name stands for that of a kindred people, who have given to this country a large and highly valued element among its adopted citizens. An officer of the Swedish army in early life, Ericsson closed his career with the illustrious distinction of being among the foremost of American mechanics.* Of the innumerable applications of mechanical art that are the fruit of his genius, many so long ago passed into general use that they have ceased to be associated popularly with his name; but his achievements in the field of naval science will remain forever a monument to his memory. To the United States Navy he gave the first *Monitor*, and in her he gave to all the navies of the world the germ of the modern battle-ship.

For these reasons, it is the Department's desire to surround the em-

* Read in connection with this what is said on page 228, Vol I.

barkation with every circumstance that can invest it with dignity and solemnity. All the vessels of war that may be available will be assembled at New York and will be directed to unite with you in paying to the deceased the honors befitting his rank and his distinguished name. The details will be regulated by you in consultation with the representatives of Captain Ericsson, and the officers of the association desiring to take part in the ceremony. The anchorage ground near the Statue of Liberty is designated as the place where the *Baltimore* will receive the remains, and the other vessels of war will be anchored in her vicinity. The marines from the ships and the station will form the guard of honor to escort the body from its present resting-place to the Battery. It will there be embarked on board the *Nina* and conveyed to the *Baltimore*, under the escort of all the available steam launches and pulling boats of the squadron, formed in double column, the steam launches preceding the *Nina*.

The Department has extended to the Minister of Sweden and Norway at this Capital an invitation to be present, which will include the members of his legation and such officers of the consular service of Sweden in this country as he may designate. Letters have also been sent to the executors of the deceased, and to Rear Admiral John L. Worden, U. S. Navy, the veteran captain of the *Monitor*, inviting them to take part in the ceremonies, and to accompany the remains to the *Baltimore*. It is the intention of the Secretary of the Navy to be present. By the publication of this letter, the Department invites all associations composed of the friends, companions, or former countrymen of Captain Ericsson, to take part in the procession to the Battery, and to report to you through their representatives for instruction as to their position in the line and other details of the ceremony.

The flag officers who may be in New York will be directed to cooperate with and assist you in carrying out this programme, the details of which you are authorized to modify as circumstances may require.

Very respectfully,

James R. Soley,
Acting Secretary of the Navy.

On August 18th the following order was issued by authority of the President of the United States:

Navy Department, Washington, August 18, 1890.

The Commandant of the Navy Yard, New York:

Sir: Upon the occasion of the embarkation of the remains of Captain Ericsson, it is the desire of the President to give solemn expression to the cordial and fraternal feeling that unites us with a kindred people, the parent source of a large

body of our most valued citizens, of whom the late inventor, a Scandinavian by birth, and an American by adoption, was the most illustrious example.

In recognition of this feeling and of the debt we owe to Sweden for the gift of Ericsson, whose genius rendered us the highest service in a moment of grave peril and anxiety, it is directed that at this other moment, when we give back his body to his native country, the flag of Sweden shall be saluted by the squadron.

The Department therefore issues the following instructions:

The colors of the squadron will be at half-mast during the embarkation.

Minute guns will be fired from the monitor *Nantucket* during the passage of the body from the shore to the *Baltimore.*

As the *Baltimore* gets under way and passes the vessels of the squadron, each vessel will masthead her colors, display the Swedish ensign, and fire a national salute of twenty-one guns. The *Baltimore* will immediately proceed to sea.

By command of the President:

J. Russell Soley,
Acting Secretary of the Navy.

Under these orders, addressed to the Commandant of the Brooklyn Navy Yard, Rear-Admiral David L. Braine, an appropriate ceremonial was arranged, and on Saturday, August 23, 1890, the remains of John Ericsson were removed from the receiving vault in the Second Street cemetery, and placed on board the *Baltimore* for transportation to Sweden. Again the Swedish singing societies gathered in the little cemetery around the coffin of their dead countryman, and sang Otto Lindblad's "Stridsbön," or battle prayer of Sweden. Then in solemn procession, through streets lined with thronging thousands of curious sight-seers, the remains of Sweden's honored son were transported to the tug at the Battery for transfer to the noble war ship waiting in the harbor, where they were placed under the protection of a guard of honor on a catafalque upon the spar-deck. In committing the remains to the charge

of the Commander of the national vessel assigned to the duty of conveying them across the ocean, Mr. George H. Robinson, one of the executors of Ericsson's estate, and a son-in-law and partner of Mr. Delamater, spoke thus appropriately:

CAPTAIN SCHLEY: In the nation's tribute to our illustrious dead the simple duty falls to us to yield to the claims of his mother-country, that she may again receive her son. We send him back crowned with honor; proud of the life of fifty years he devoted to this nation, and with gratitude for the gifts he gave to us.

Was he a dreamer? Yes. He dreamed of the practical application of screw propulsion, and the commerce of the world was revolutionized. He dreamed of making naval warfare more terrible, and the *Monitor* was built. After one trial, at a most critical period of this nation's history, where were the navies of the world? The London *Times* said: "England has no navy." Again he dreamed, and the *Destroyer*, with its submarine gun, was born. He dreamed of hot air, and behold ten thousand caloric engines. He dreamed of the sun's rays in sandy deserts, where water was hard to get, and the solar engine came; and so he dreamed and worked for seventy years.

He bore the strain of unremitting toil, and at the end his last words were: "This is rest." Well earned, benefactor of the world!

To you, Captain Schley, we commit these remains. The honorable duty is yours. Deliver them to his native country. We keep his memory here.

Replying, Captain Schley said:

TO THE EXECUTORS OF THE JOHN ERICSSON ESTATE.

GENTLEMEN: The officers and men of this splendid cruiser regard their assignment, by the honorable Secretary of the Navy, to the sacred duty of conveying these honored remains of the late John Ericsson to their home in Sweden with peculiar pride and pleasure. It will be their bounden duty to watch over and guard them with an interest that is increased by the fame of this great man, whose part during the most important epoch in our history is so widely understood and so justly appreciated by our people. Ericsson's genius created a new instrument of war, and it is not too much to say the latest modern battle-ships are but modifications in one form or another of his original idea as perfected in the little *Monitor*. The Navy which we represent will be justly proud that their brothers in arms have been selected to perform this last sacred duty. And you need no assurance from me that this mission will be dutifully and lovingly performed.

The day was a beautiful one, and everything conspired to give solemnity and effect to the ceremonial: the buildings appropriately draped; the flags at half-mast, Sweden's standard of blue and orange mingling with the stars and stripes; the fine naval display upon the water, and the salute from the forts in the harbor; and the double line of saluting war-ships between which the *Baltimore* proceeded to sea, flying at the fore the despatch-flag to proclaim that she was upon the king's business and must not be halted or interfered with on her journey.* What man has been more highly honored in American history? What other man has better deserved such honors?

After a prosperous voyage of nineteen days, the *Baltimore* arrived at Stockholm and transferred her sacred charge, on September 14th, to the custody of the Swedish Government. The vessel reached the Swedish capital on Friday, having been detained somewhat by foggy weather, and the ceremony of transferring the remains was postponed until the Sunday following, September 16, 1890. Three officers of the Swedish Navy and four nephews of the deceased had been appointed a committee of reception. They proceeded to the *Baltimore.* Captain Schley delivered the body to the Minister of the United States to Sweden, the Hon. W. N. Thomas, Jr., and he in turn consigned it to Admiral Peyron.

"I transfer these honored ashes with all reverence," said Mr. Thomas, in his brief address, "for well I know how grandly the hand, that now lies cold and still within this casket, has wrought for America and for humanity. At a critical moment in the history of the United States, John Ericsson, by the creation of his genius, rendered illustrious service to his adopted country, and saved her from great peril. And the Republic is not ungrateful. Lovingly as Agrippina bore home to Rome the ashes of Germanicus, so tenderly and honorably America brings back the body of Ericsson, that the land which was his

* The despatch-flag is a white square flag with five blue crosses. Hoisted forward, this flag denotes important and urgent special service, which must not be interfered with by any officer junior to the one by whom the vessel was despatched; in this case the supreme head of the Navy, the President of the United States. See Preble's History of the Flag of the United States, p. 675.

cradle may also be his grave. The body of Ericsson we restore to you, but his memory we shall ever retain in sacred keeping; or rather we will share it with you, and with the whole world."

Sailors belonging to the American man-of-war carried it on board a steam barge commanded by a captain in the Swedish Navy, and this was followed to the shore by a procession of boats, the vessels in the harbor flying their flags at half-mast, and the *Baltimore* and the forts firing minute-guns. At the landing, the Governor of Stockholm received the body, and it was borne by the American sailors to a pavilion; the troops paraded as an escort, presenting arms, and the bells tolled solemnly. At the railway station a train was in waiting to convey the body to its final resting-place at Filipstad. After a simple service, consisting of the singing of Swedish hymns and the recital of a poem, the hearse proceeded to the station, followed by an escort, including the representatives of the King, the Crown Prince, and the Government; the American Ministers to Sweden and to Denmark; the officers of the *Baltimore*, and the municipal authorities of Stockholm. The solemn dignity of the ceremonial made a profound impression, as had the similar ceremonial in New York. Through double ranks of Swedes, standing reverently with uncovered heads, the funeral cortege proceeded to the cars waiting to convey them over the railroad Nils Ericsson had built, and Hjalmar Elworth superintended, to their beautiful resting-place among the Vermland hills.

The funeral train was received along the route from Stockholm to Filipstad with numerous manifestations of sorrow and respect, for Ericsson was remembered there, not only as the great engineer, but as one who had let the cry of the poor come unto him, and whose heart was always open to the humble classes who form the great body of every community. Kings might honor him, but the common people loved him as a friend and brother. Arrived at Filipstad in Vermland, the body was borne by twelve miners into a church, where the Lutheran services for the dead were performed, and on the morning of September [illegible] was deposited in its final resting-place—a [illegible] prepared for its reception in the

adjoining cemetery, the finest in Sweden. The honors accorded by the Government of the United States to their dead won the hearts of the Swedes, and, as the representatives of the United States, the officers of the *Baltimore* were received with the most distinguished courtesy, the audience rising *en masse* as they appeared at the opera, and the king giving a dinner in their honor.

Few men of his profession have had a greater opportunity than John Ericsson for acquiring wealth as well as fame, but his indifference to pecuniary considerations prevented his advancing on the road to opulence beyond the stage of comfortable independence. In a letter written November 7, 1884, he said: "They imagine in Sweden that I now possess a large fortune, not considering what it has cost me to be useful to my fellowmen, especially my native country, for which I have worked out a complete system of defence. They do not know that for nearly twenty years (during which time I have spent a million crowns), I have not worked for money. They know that during these years I have produced various machines that now pay well, but they do not know that I have resigned these inventions to certain mechanical manufacturers who most liberally consented to construct experimental machines for me at a time when I was not able to pay for the work." The fortune which he estimated at one time at nearly $300,000, had greatly diminished at the time of his death, and the inventory showed a total valuation of only $100,000, including $72,715.42 for his personal property, the house in Beach Street, which was sold for $19,000, and a house in Abingdon Square. His large investment in the *Destroyer* was dependent upon Government action for possible value, and the still standing *Princeton* claim was an even more uncertain asset. Both were required to make good the bequests of his will, amounting altogether to $147,000, distributed as follows:

To the assistants in his office	$52,000
And twenty per cent. of certain recent inventions.	
To female dependents	45,000
To his friends Von Rosen and Adlersparre	15,000
To the widow of his son Hjalmar	15,000
To the children of his sister	20,000
To his nephews and nieces the residue of his property.	

This is the text of his will, which makes characteristic disposition of his shrunken estate :

I, JOHN ERICSSON, Civil Engineer, of the City of New York, being in good health and sound mind, do hereby make, publish, and declare this my last will and testament, hereby revoking any and all other will or wills heretofore executed by me.

Item I. I give and bequeath to the six children of my deceased sister, Anna Carolina Odhner, Christina Sophia, Carolina Gabriella, Ingeborg Wilhelmina, John Olof Emanuel, Class Theodor, and Anna Mathilda, twenty thousand dollars, to be divided equally among them. And in the event of any one or more of them dying before the said legacy is paid, then and in that event, the share that would have been received by such deceased if living, shall be paid to the heirs of said deceased in equal portions.

Item II. I give and bequeath to Hjalmar Elworth, Superintendent of the Swedish State Railroad, fifteen thousand dollars ; and in the event that the said legatee shall not be living at the time of my death. then and in that event, the said legacy shall be paid to the widow of said Hjalmar Ellworth if she shall be living. If not living, then and in that event said legacy shall be paid to her heirs.

Item III. I give and bequeath to Commodore Axel Adlersparre, residing at Stockholm, in Sweden, five thousand dollars ; and in the event that he shall not be living at the time of my death, then and in that event, the said legacy shall be paid to the lawful heirs of the said Axel Adlersparre in equal portions, share and share alike.

Item IV. I give and bequeath to the wife of Commodore Axel Adlersparre, five thousand dollars ; and in the event that she shall not be living at the time of my death, then and in that event, the said legacy shall be paid to the lawful heirs of the said wife of Commodore Axel Adlersparre.

Item V. I give and bequeath to Count Adolph Eugene Von Rosen, of Stockholm, Sweden, five thousand dollars.

Item VI. I give and bequeath to Ann Cassidy, my housekeeper, fifteen hundred dollars.

Item VII. I give and bequeath to Samuel W. Taylor, one of my assistants, five thousand dollars ; and in the event that he shall not be living at the time of my death, then and in that event, the said legacy shall be paid to the lawful heirs of the said Taylor in equal portions, share and share alike.

Item VIII. I give and bequeath to Valdemar Frederick Lassöe, one of my assistants, five thousand dollars ; and in the event that he shall not be living at the time of my death, then and in that event, the said legacy shall be paid to the lawful heirs of the said Lassöe in equal portions, share and share alike.

Item IX. I give and bequeath to Charles William Maccord, Professor in the Stevens Institute, two thousand dollars; and in the event that he shall not be living at the time of my death, then and in that event, the said legacy shall be paid to the lawful heirs of the said Maccord in equal portions, share and share alike.

Item X. I give and bequeath to Miss Sarah Thorn, residing at No. 5 Abingdon Square, in the City of New York, fifteen hundred dollars.

Item XI. I give and bequeath to Miss Mary Austin, residing at No. 414 East Thirty-second Street, in the City of New York, five hundred dollars.

Item XII. I give and bequeath to Miss Sarah Thorn, for and during her life, all that house and lot now occupied by her, and known as No. 5 Abingdon Square, in the City of New York.

Item XIII. I give and devise in trust to my executors and trustees hereinafter named, seventeen thousand dollars, to be separated and set apart for the following purposes: To invest the same in good securities, and to pay the interest and dividends received thereon to Ann Cassidy during her natural life; the payments to her to be made monthly, and as nearly as possible the average one-twelfth part of the yearly interest or dividends of said sum invested.

Item XIV. I give and devise in trust to my executors and trustees hereinafter mentioned, seventeen thousand dollars, to be separated and set apart from the rest of my estate for the following purposes: To invest the same in good securities, and to pay the interest and dividends received thereon to Miss Sarah Thorn, of No. 5 Abingdon Square, in the City of New York, during her natural life; the payments to her to be made monthly, and as nearly as possible the average one-twelfth part of the yearly interest or dividends of said sum invested.

Item XV. I give and devise to my executors and trustees hereinafter named, seven thousand five hundred dollars, to be separated and set apart from the rest of my estate for the following purposes: To invest the same in good securities, and to pay the interest and dividends received thereon to Miss Mary Austin, of the City of New York, during her natural life; the payments to her to be made monthly, and as nearly as possible the average one-twelfth part of the yearly interest or dividends of said sum invested.

Item XVI. I give and devise in trust to my executors and trustees hereinafter mentioned, twenty thousand dollars, to be separated and set apart from the rest of my estate for the following purposes: To invest the same in good securities, and to pay the interest and dividends received thereon to Samuel W. Taylor, or his present wife, during their joint lives; and upon the death of the last survivor I direct my executors and trustees to pay the said principal sum to the children of said Taylor in equal portions, share and share alike.

Item XVII. I give and devise in trust to my executors and trustees hereinafter named, twenty thousand dollars, to be separated and set

apart from the rest of my estate for the following purposes: To invest the same in good securities, and to pay the interest and dividends received thereon to Valdemar Frederick Lassöe and his present wife, quarterly during their joint lives; and upon the death of the last survivor I direct my executors and trustees to pay the said principal sum to the children of the said Lassöe in equal portions, share and share alike.

Item XVIII. All the remainder of my estate, both real and personal, I hereby give and bequeath to the children of my deceased sister Anna Carolina Odhner, and to Hjalmar Ellworth, in equal portions, share and share alike. And in the event of any one or more of them dying before the said legacy is distributed, then and in that event, the share that would have been received by such deceased person or persons, if living, shall be paid to the heirs of said deceased person or persons in equal portions.

Item XIX. And I hereby name as my executors and trustees of this my last will and testament, Eden Sprout, counsellor at law, George H. Robinson, William Henry Wallace, and Cornelius H. Delamater; and I hereby give to them full power and authority to sell and convert all my goods and estates, both real and personal, into money, and to invest the same as may seem to them best, and to do all things necessary and proper to carry into effect and execute this my last will and testament.

In Witness Whereof I have hereunto set my hand and seal this fifteenth day of May, in the year one thousand eight hundred and seventy-eight.

J. Ericsson.
[Seal.]

To the will was added this codicil:

I, John Ericsson, of 36 Beach Street, in the City, County, and State of New York, having made and declared my last will and testament, bearing date the fifteenth day of May, one thousand eight hundred and seventy-eight, do now make this codicil, and direct that it shall be taken as a part of my said will. I do hereby nominate and appoint my friend, Cornelius S. Bushnell, of New Haven, Conn., to be one of my executors, he taking the place of Cornelius H. Delamater, deceased. In addition to the bequests to Valdemar F. Lassöe and Samuel W. Taylor, contained in my said will, I hereby give and bequeath to each of them ten per centum of my interest, whatever it may be, in the emoluments and profits that may be derived from the sale of expansion engines, manufactured and sold under certain letters patent granted to me by the United States, dated December 6, 1887, and numbered 374,354, for an improved compound steam-engine. I also give and bequeath to the said Valdemar F. Lassöe and Samuel W. Taylor, and to each of them, the same amount of interest as the above, namely ten per centum, of my interest in the emoluments and profits that may be derived from the sale of hydraulic pumps manufactured and sold under any patent

that may be granted to me by the United States; an application for which patent was filed by me last year and is now pending. The rest and remainder of my interests in the emoluments and profits arising from sales under the above-mentioned two patents I give and bequeath to my nephews and nieces, to be divided equally between them, or if any one of them may have died, their children to receive the share of the parent, to be equally divided between them. I also give and bequeath to said Valdemar F. Lassöe and Samuel W. Taylor, and to each of them, ten per centum of my share in the interest of profits and emoluments that may arise from the manufacture and sale under any patents that may be granted to me by the United States for certain improvements in caloric engines, for which it is my intention to apply for patents. These improvements are embodied in two motive engines just built for me, and designated as solar-engine and sun-motor.

The rest, residue, and remainder of my interests in the so-called solar-engine and sun-motor, under any patents therefor, I give and bequeath to my nephews and nieces in equal parts, and in case of their death to their children.

So ends the story of John Ericsson—the son of Olof, the son of Nils, the son of Eric, the son of Magnus Stadig the miner. I have set forth as faithfully as I could what he actually accomplished; the relative value of his work, it is not for his biographer to determine. For that is required a point of view impossible to one who draws too near his subject. Though it is true, as I have said already, that his inventions were not the result of waking dreams, but of the studious application of engineering and mechanical knowledge to new problems, those who knew him most intimately were accustomed to speak of him as in all respects the most original man they had ever known; and originality was the striking feature of his engineering work. Severely logical as were his methods from his own point of view, there was much in his mental processes suggesting that faculty of unconscious cerebration, or whatever it may be called, which is the accompaniment of the loftiest flights of human effort in all departments. "Ordinary talent produces artificially, by means of rational selection and combination, guided by its æsthetic judgment. . . . It may accomplish something excellent, but can never attain to anything great . . . nor produce

an original work. . . . There is wanting the divine *frenzy*, the vivifying breath of the Unconscious." *

This "activity and efflux of the Intellect freed from the domination of the Conscious Will," however variously it may be accounted for, has been recognized in all times and by all schools. With the Latins it was the work of a tutelar spirit; with Plato, "the divine frenzy, gift of holy *daimones*;" with the Jewish prophets, "the lifting up of the spirit." Bacon speaks of it as a kind of felicity, working "not by rule;" Carlyle as "the clearer presence of God Most High in a man;" Hartmann as "the vivifying presence of the unconscious." From pagan philosopher to German pessimist, all take note of its existence. In an article on "Genius," Mr. Stedman includes Ericsson in his illustrations of this inborn faculty "appertaining to the power and bent of the soul itself." †

Schopenhauer tells us that "what is called the stirrings of genius, the hour of consecration, the moment of inspiration, is nothing but the liberation of the intellect, when the latter, for the time exempt from the service of the will, . . . is active all alone, of its own accord." Be this as it may, he truly says that "in such moments, as it were, the soul of immortal works is begotten."

It was in such moments that John Ericsson did his best work. When he had a difficult problem to solve he would lean back in his chair, with his head resting against the wall, and sink into a quiescent state, approaching unconsciousness. Then, as he was accustomed to say, his best thoughts came to him. Once, indeed, a puzzling combination in his solar engine was worked out for him in a dream. He had a profound belief in his own mission, and dwelt with interest upon the history of the first Napoleon, as illustrating the tide of destiny that carried him in like manner on to his ordained end.

"Men of genius," said Dean Stanley, over the grave of Charles Dickens, "are different from what we suppose them to be. They have greater pleasures and greater pains, greater affections and greater temptations, than the generality of man-

* Hartmann's Philosophy of the Unconscious, English edition, vol. i., p. 267.

† See article "Genius," by Edmund C. Stedman, in the New Princeton Review for September, 1886.

kind, and they can never be altogether understood by their fellow-men." "Genius implies always a certain fanaticism of temperament," James Russell Lowell tells us, and this was the secret of Ericsson's difficulties. In his own department he was controlled by imagination, and if his life was one of constant friction, it was, as he himself explains, because he saw so much that lay beyond the vision of those with whom he dwelt. He was never a popular man with his profession, and he felt that much of the professional judgment passed upon him was the result of prejudice or jealousy. His subordination to the conditions under which *he* must work no doubt explains in some measure his impatience of suggestion, and his contempt for adverse opinion. So unwilling was he to follow the lead of others, that the fact that an expedient was in common use was, in his mind, rather an argument against it than for it. It was only by disregarding precedent and example that he could free his genius from restraint and accomplish his greatest results: and thus the habit of independence so grew upon him that in his later years, when engineering and mechanical science had made progress he had not taken full note of, he refused to avail himself, as he might have done greatly to his advantage, of methods approved by experience. Let us, in spite of his own doubts, accept the cheerful faith of his friend Adlersparre, that assigns to him a kindlier sphere beyond, where just appreciation and intelligent sympathy may stimulate him to still higher efforts.

In the dream of Piranesi, as described by Thomas De Quincey, appear Gothic halls, covered with engines and machinery expressive of enormous forces overcoming vast resistance. Creeping along the sides of this hall rises a staircase whereon Piranesi is seen groping his way upward. Just beyond him this staircase terminates abruptly, without balustrade to stay the final step that is to plunge him into the depth below. Here, then, must end the labors of Piranesi. But behold beyond a still higher flight, with Piranesi still ascending, and again and again still more aerial flights, until the unfinished stairs and Piranesi both are lost in the upper gloom of the hall.

Fitting symbol is this of the labors of John Ericsson.

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